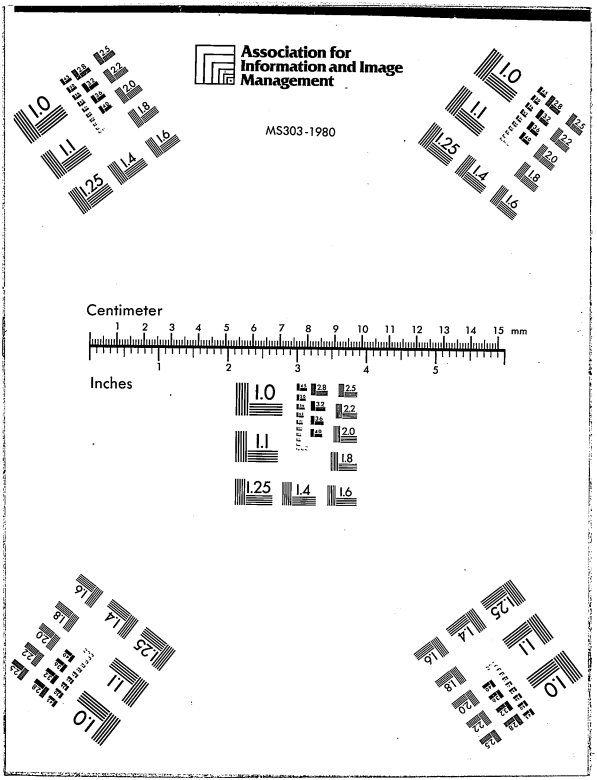
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5.0
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A SELECTIVE MICROFILM EDITION

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1987

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Thomas A. Edison Papers
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A SELECTIVE MICROFILM EDITION
PART II
(1879-1886)

REEL 30

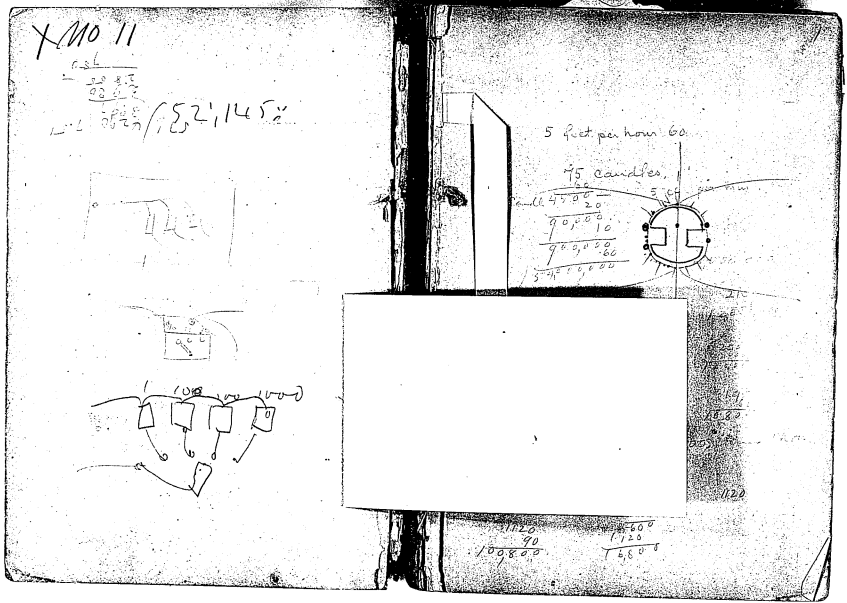
NOTEBOOK SERIES (NBK-8)

Menlo Park Notebooks, #11 - #21

Menlo Park Notebook #11 [N-78-12-28]

This notebook covers the period December 1878-June 1879. Most of the entries are by Francis Upton. There are also entries by Edison and Charles Batchelor. All of the material relates to experiments on electric lighting. Included are numerous notes, drawings, and calculations about generators; calculations relating to electric power distribution systems; and notes by Upton on "elements of uncertainty" in experiments and tests. The book contains 284 numbered pages.

Blank pages not filmed: 4-5, 48-81, 92-93, 186-187, 210-221, 242-245, 248-249.


5 feet per hour 60
75 candles,
5 60
20
10
60
120
90

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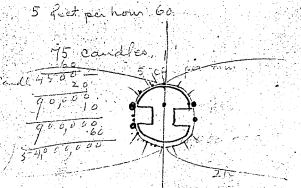
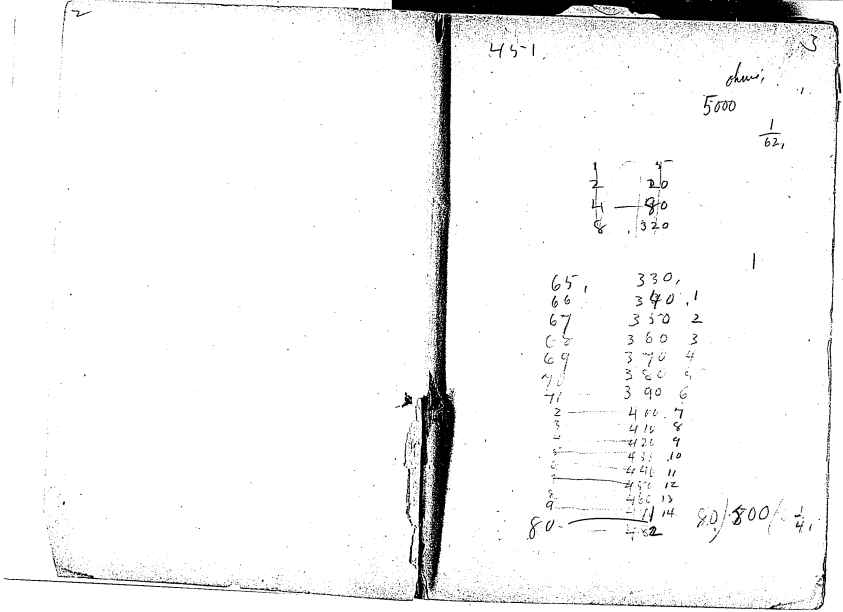




Gas, estimate cost of

10 000 — with 900 coke.

5. 2½ 5000.
1¼ — 10,000
675
90
8,500

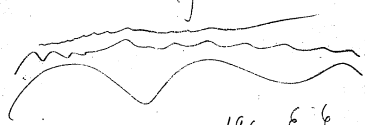
370.

5. 6 . 2500.
10,000.

1300. 10,000

1300 Coal gives Power Available
1300 Coal " . 650 hp, 1 hour —

650
Jabalpur. 13 hours
13 hours —



$\frac{X^2}{265} \times 44.3 = 3300$

$X^2 = \frac{3300 \times 265}{44.3}$

141

196 | 6 6
17 | 4
1972

8.51185
2.42832
8.3536
2 | 4.2953
2.1476

4.345175
135
2 | 4.345315
2.172657

172657
172603
196 | 5454 (2
88
21

146.52

265 ohms

$\frac{X^2}{265} \times 44.3 = 3300$

$X^2 = \sqrt{\frac{3300 \times 265}{44.3}}$

22147
2214

22
2214.7

265
33
3300
79500
7950
7455
795
795
0

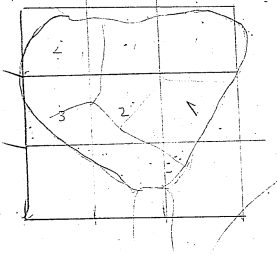
148.3 44) (24
116
1184 6
1592 3
148
2.19.04

10

Size of gas burner

1380. 1-lb platina.

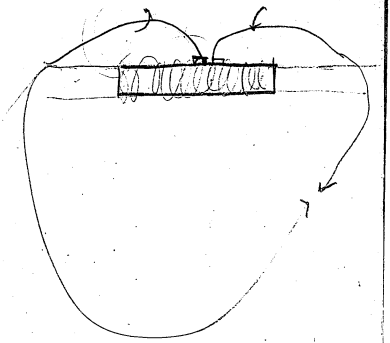
12 11 1380. dry



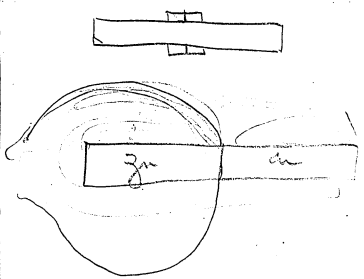
12000. 12

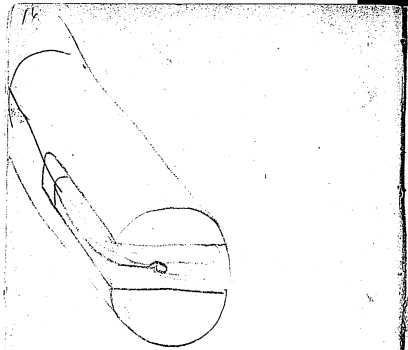
6. 25

Non Commutator machine



Line of force
due current in Thing





To show induction by automatic

Chem cup

To coil

To coil

Pivot

Rod

Key

To Large cells

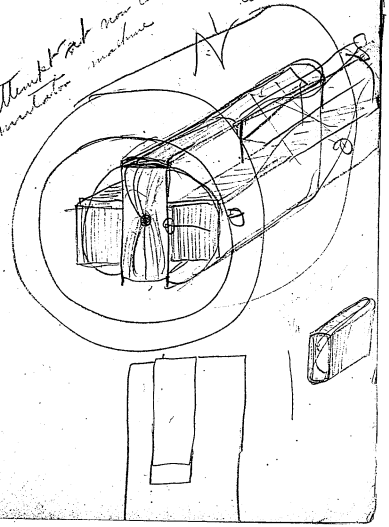
15

15

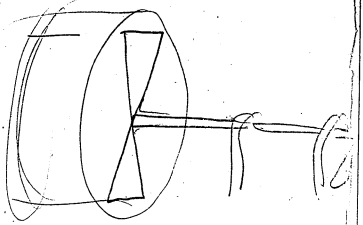
Dec 28 1896

Charles Latrobe

Attempt to work new conv- inventor machine



Attempt at own commutator



141
141

141

141
141

141

1 3 6

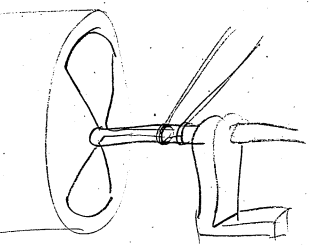
145 3
145

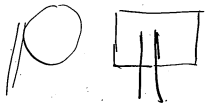
1184
592 3
145

21904
44

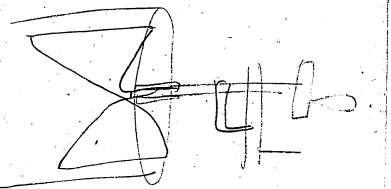
7616
6
---
265 3716 37 m

Attempt at non commutator - 4

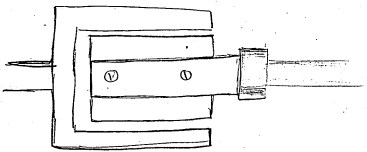


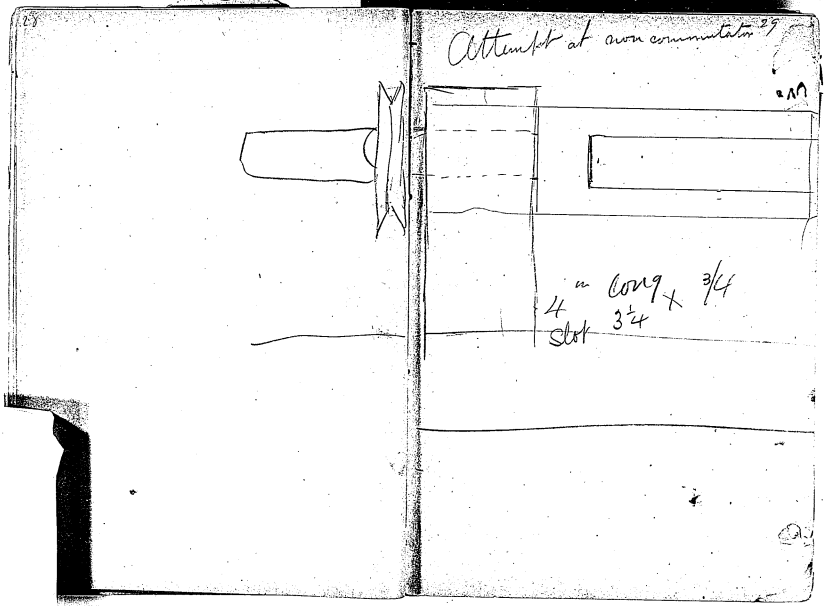


Attempt at new commutator

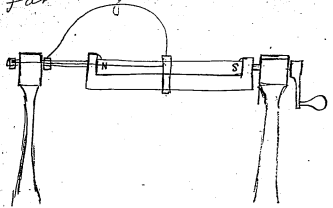
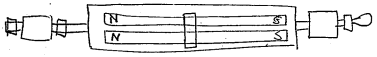


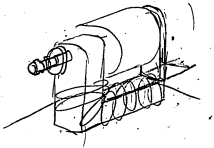
Attempt at new Commutator




Attempt at worm commutator 29
4" long x 3/4
slot 3 1/4

Lam day machine. 31





$$\frac{x^2}{265} \times 443 = 3300$$

$$x = \sqrt{\frac{3300 \times 265}{443}}$$

265 | 3300 | 9500 | 795 | 2050 | 1770 | 2800 | 2385 | 415

443) 97450 (22147

884

1410

1329

810

443

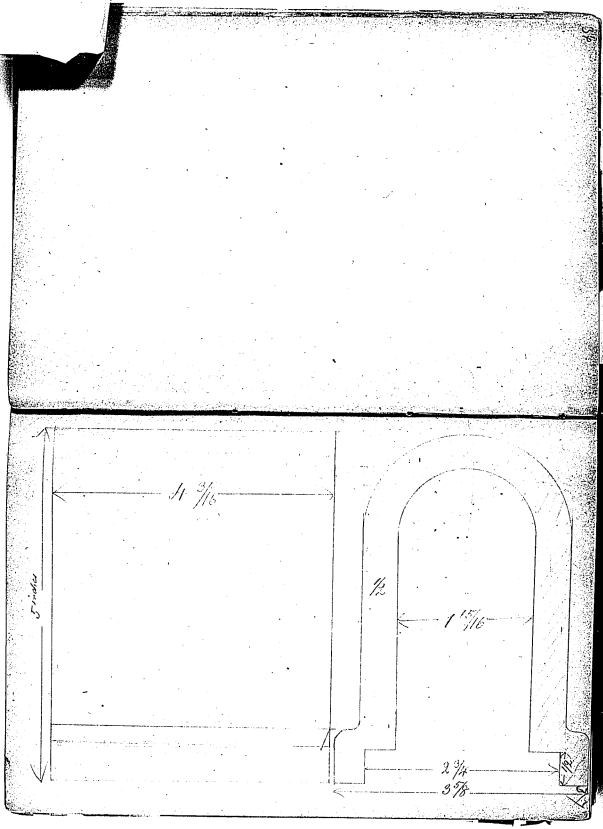
367

22147

4.345178
13 | 4.345915
2.172657

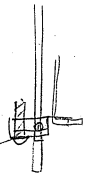
1600

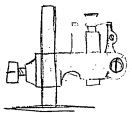
13 | 120 | 2


1 3/16
1/2
1 15/16
2 3/4
3 5/8

Dimensions of the magnets
machine
Cores 8 feet 6 inches long
Cores 4 inches diameter

Armature made of
Shaft on which is wooden
bobbin on this is
wound wire to the thickness on
each side of an inch (1)
on this is fitted a shell (6½)
six thirty-seconds long to be
wound like the other shell
with 25 coils of 3 layers
of wire that Dudee [illegible]





If $\frac{18}{16}$ of an inch of radiating surface per horsepower gives 15 candle power per $\frac{3}{16}$ radiating surface — how many units of energy will it require per $\frac{1}{16}$ —

33000 / 18

18 / 33000 (1833
18
150
144
60
54
.6

1833.
5
9165.

5

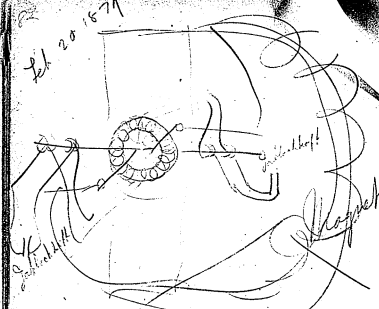
9165 / 33000 (3
27495
5505

25 — .16.

Machine $100
20 lamps
$5 $2000

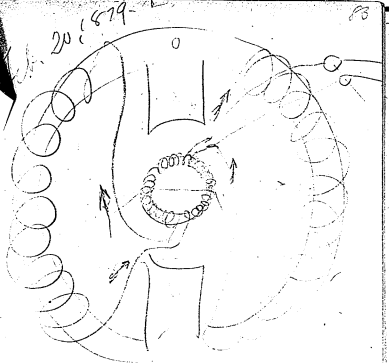
Pages 47 to ~~84~~ 81
omitted in Nov. 1879 Edn.

Feb 20 1879



Split the ring and use for Commutator, and for the field magnets.

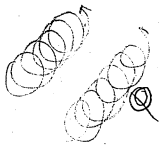
Feb 20 1879



Winding Armature 8

Feb. 20 1879

Attempt at new commutator



Feb. 20 1879.

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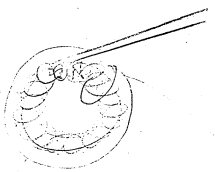
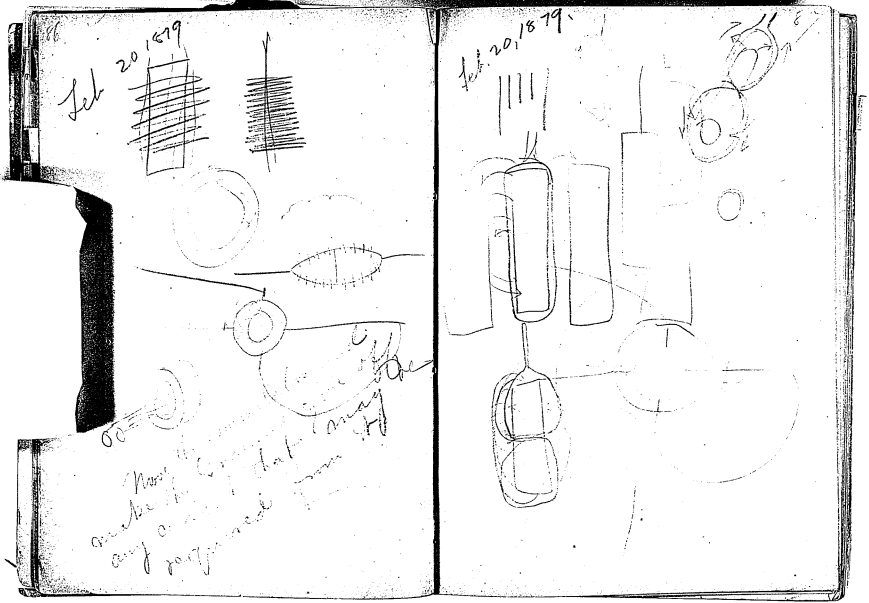
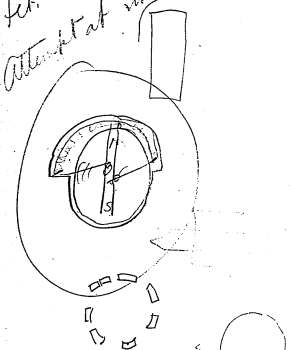



Feb 20 1879
Feb 20, 1879.

Feb. 20 1879

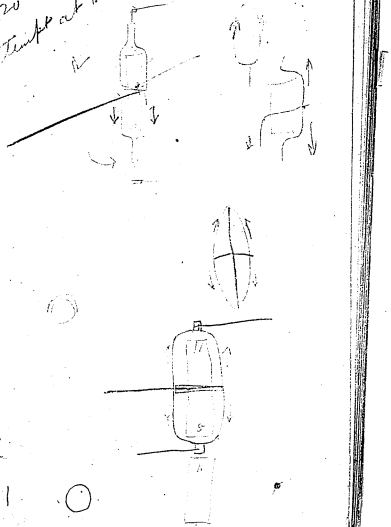
Attempt at new Commutator

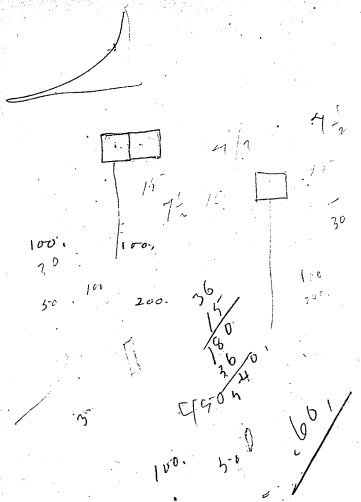


Feb. 20 1879

attempt at new Commutator

89

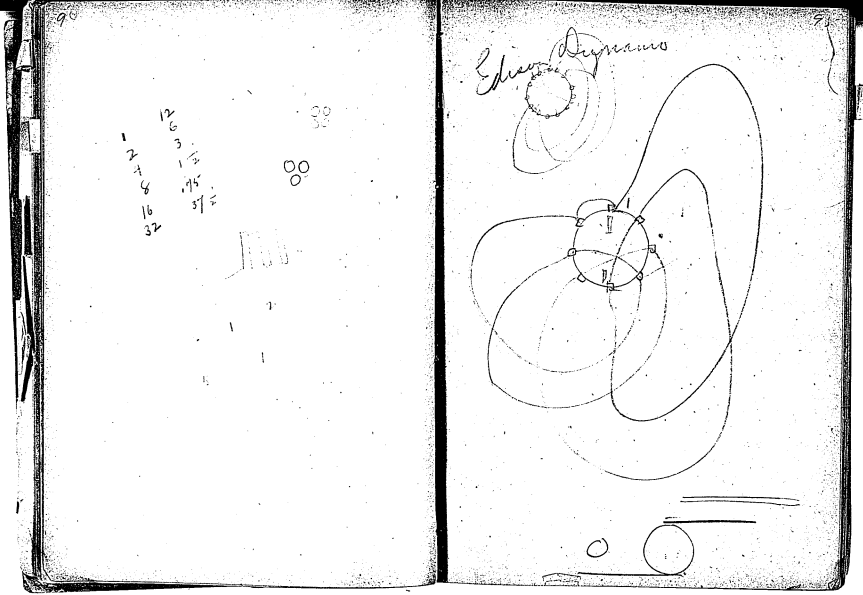




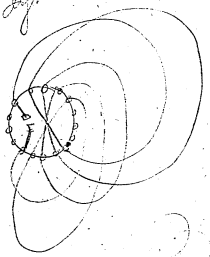
3 1/4

1/4 inch 100 units E. CP 15
1/2 " " 7 1/2
1/2 " 280 = 15
1/2
1/4 200 = 30

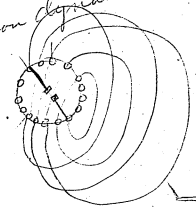
15
1. 1/16



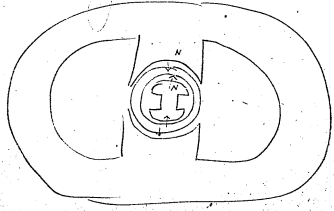
Edison Dynamo



Edison Dynamo



Field

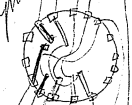


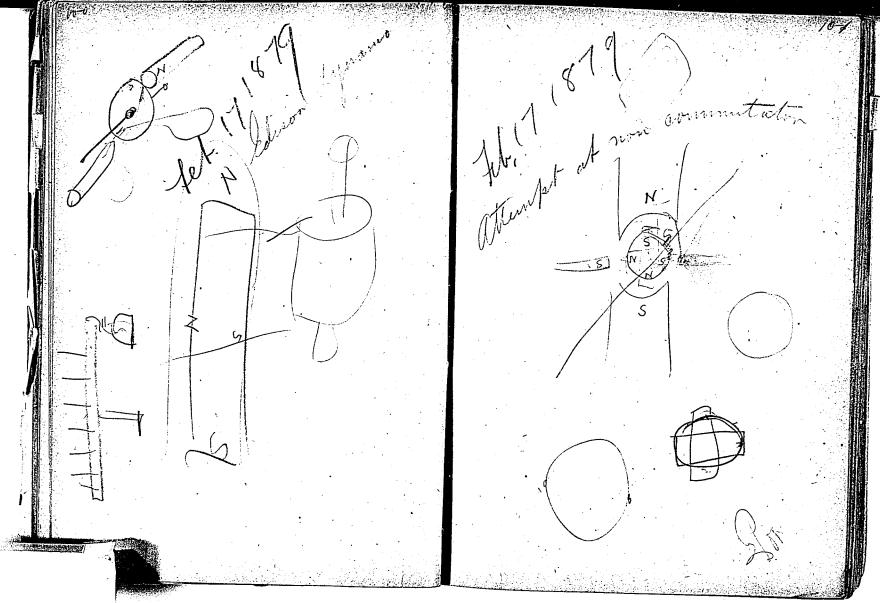
98

99

Feb. 17, 1879.

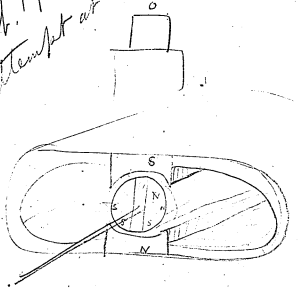
Elem. dynamo




Feb. 17 1879
Edison
Feb. 17 1879
Attempt at new commutator
N
S
S
N

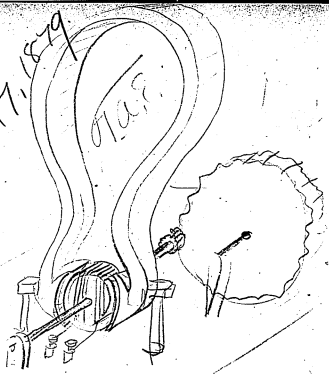
Feb. 17 1879

Attempt at ... commutator



17

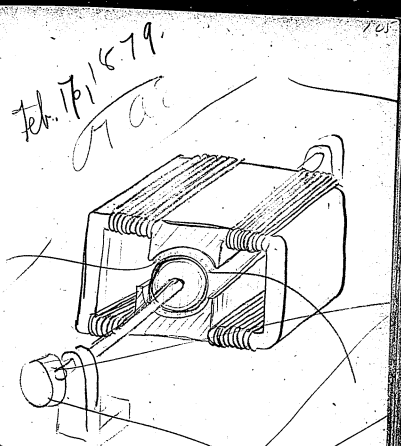
Feb. 17, 1879.



Attempt at non-commutator

105

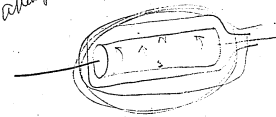
Feb. 17, 1879.

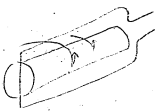


Attempt at from commutators

did not work Feb. 20

attempt at iron commutator

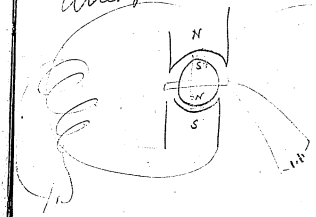


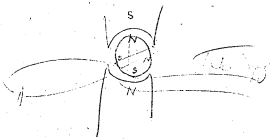


Feby 17 1879

T.A.E.

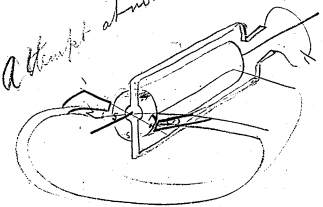
Attempt at iron commutator

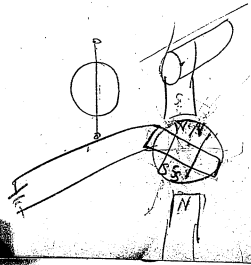




Feb. 16

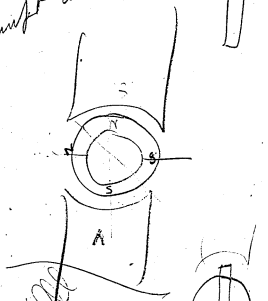
a Attempt at non commutator





Feb

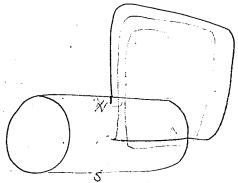
Attempt at non commutator



1 1/4 inch red.
1 inch white. red
same current.

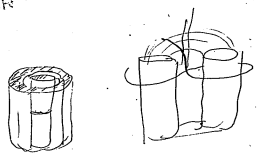
2 Pumps - 7

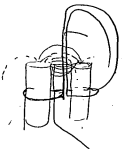
Faraday machine

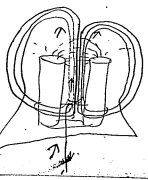


112

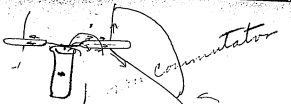
attempt at own commutator



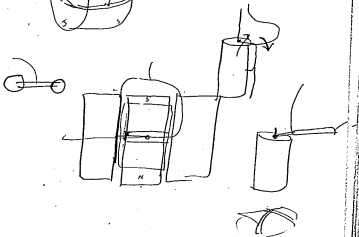


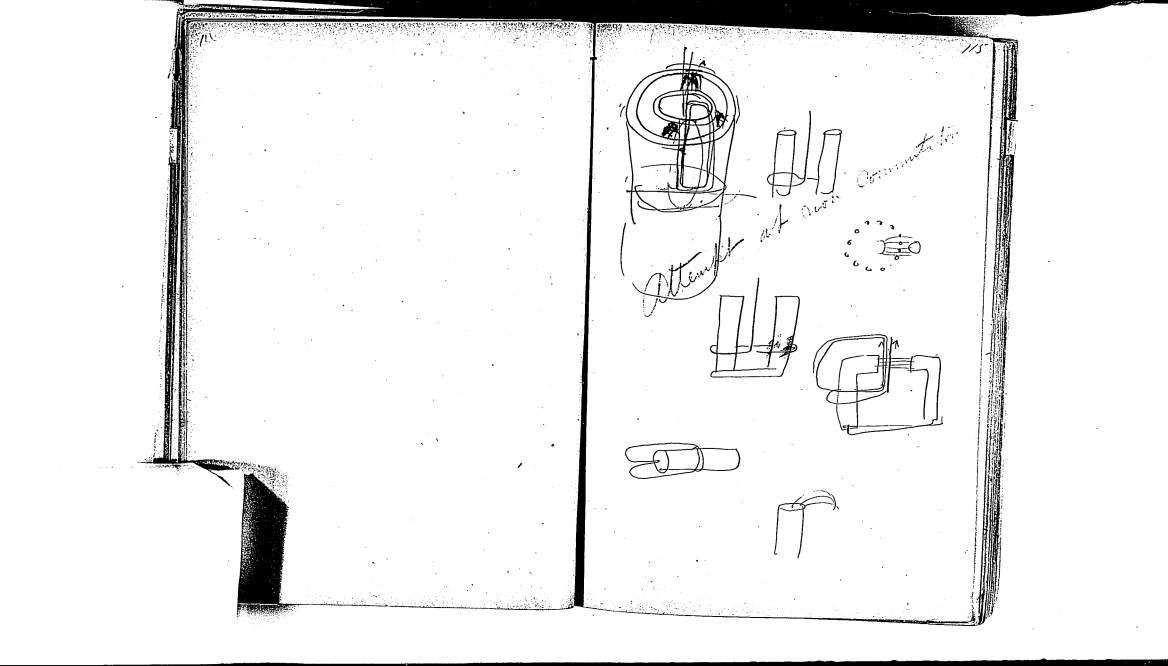


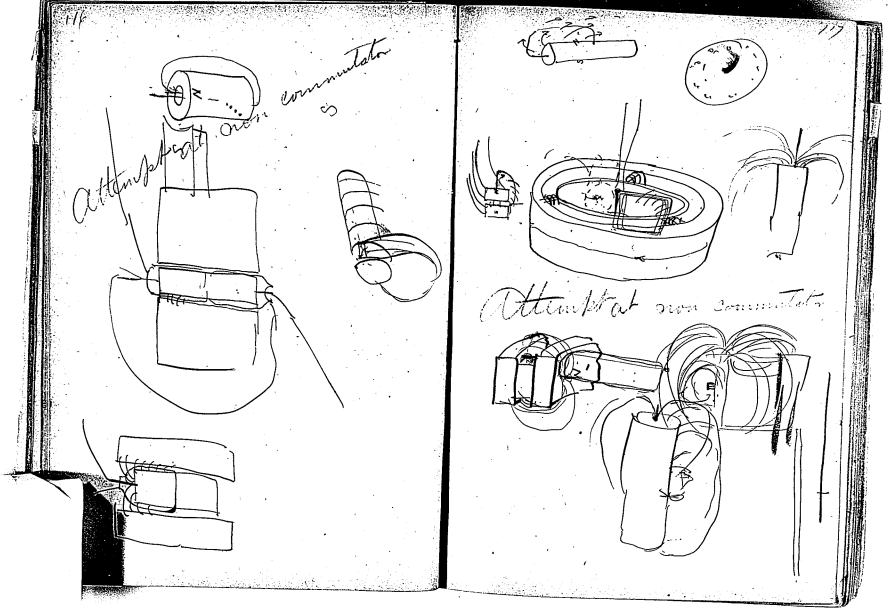
113

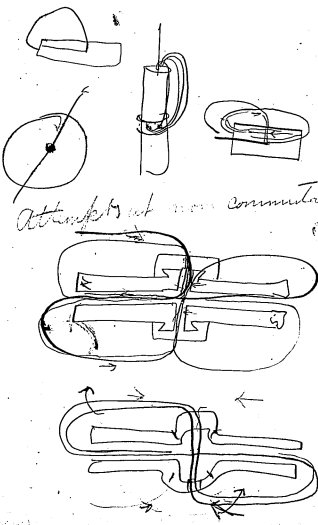


attempt at



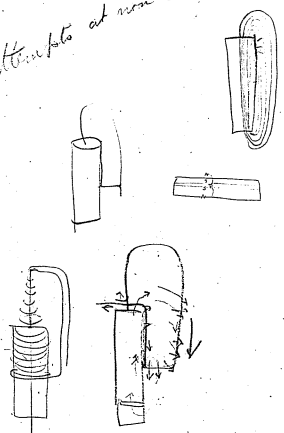




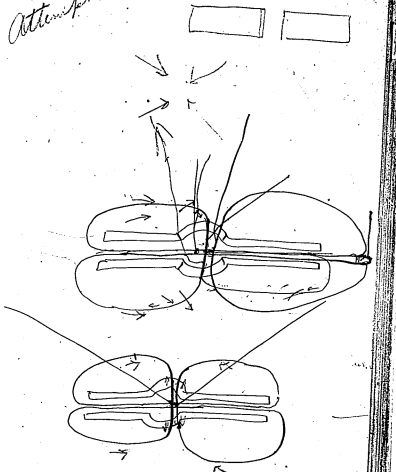

Attaching at commutator

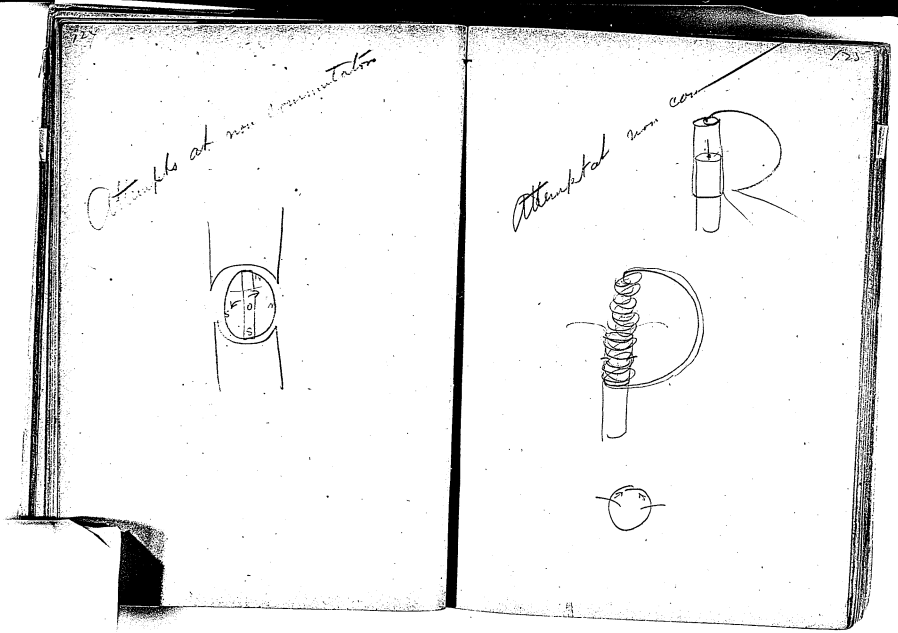
Attempts at non commutator

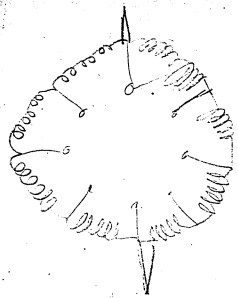
Attempts at new commutators

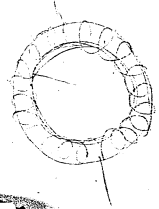


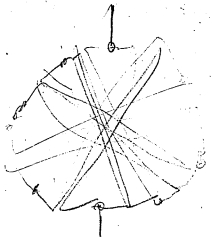
Attempts at new commutators

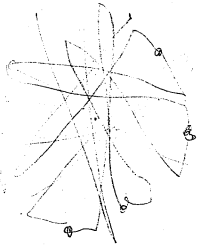


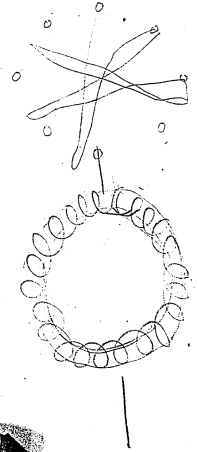


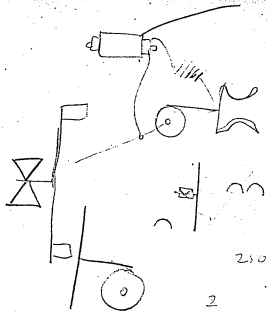












250

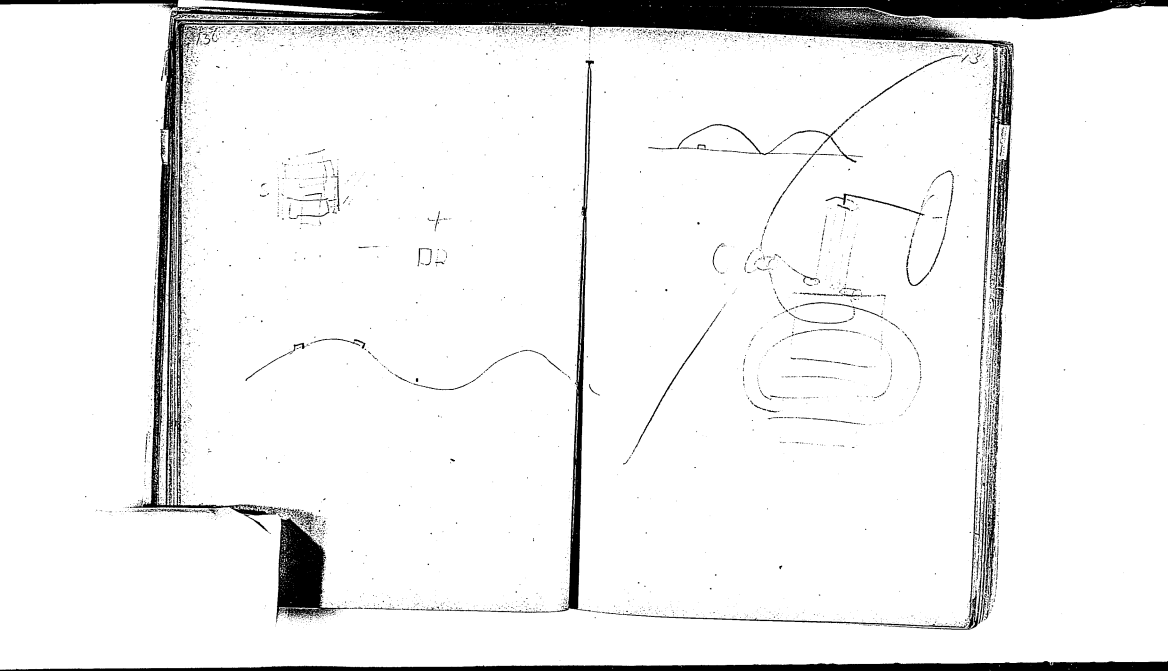
2

5, Positive
5⁻ negative —

normal
5. wires

5.
10.

spec. 5⁻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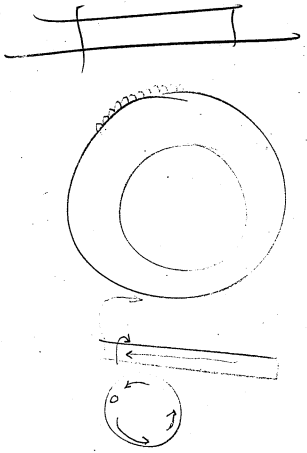
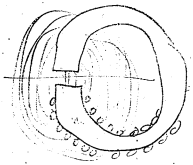
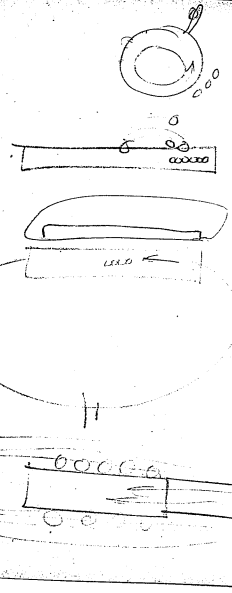






136

$\frac{1}{2}$

$\frac{30}{16}$

$\frac{1}{18}$.

6. $7\frac{1}{2}$

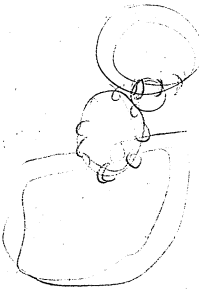
3.

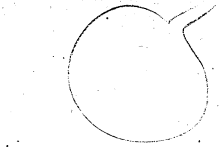
6	$1\frac{1}{4}$
12	$2\frac{1}{2}$
24	5.

137

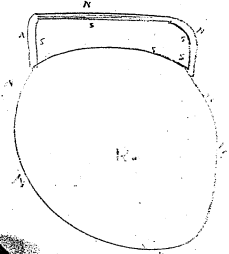
4.3

7
49
25





Phil.



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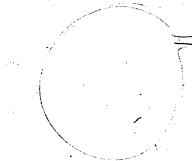
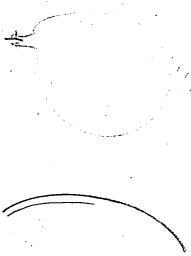
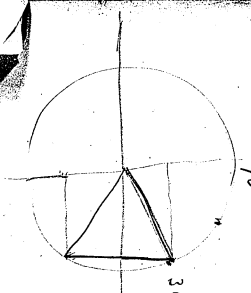






$\frac{9}{16}$ $\frac{12}{128}$ $\frac{13}{128}$ $\frac{14}{128}$ $\frac{15}{128}$ $\frac{16}{128}$ $\frac{17}{128}$ $\frac{18}{128}$

12)13,
1.093
$\frac{3}{16}$

$\frac{3}{16}$ $\frac{4}{16}$

1.33

6 (33 ∞ 0
55 2 0
1.15
27560
55
55
6325.06

3)5
1.666

1.288 .1096
3.7404
3.8500

7080

3 | 16 / 2 — 5500 — 1.411 — 3.7404 + .1495 = 3.8899 — 7760.

3 | 17 / 2.32 — 1.526 — 3.7404 + .1836 = 3.9238 — 8390

3 | 18 / 2.66 — 1.63 — 3.7404 + .2122 = 3.9526 — 8950

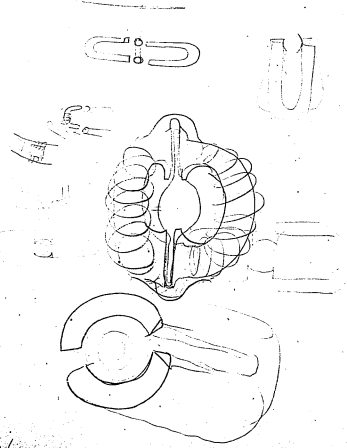
3 | 9 / 3 — 1.732 — 3.7404 + .2385 = 3.9789 — 9530

3 | 10 / 333 — 1.824 — 3.7404 + .2611 = 4.0015 — 10.000

3 | 12 / .6667 — 1.8225 — 3.7404 + .1911 = 3.6521 — 4489

3. | 1. / .333 — (.5325 / 1.7612) (.4771 / 238) — 3.7404 + 1.7612 = 3.5016 — 3174

1/16	3174	7/16	7 | 8390 = 1198
2/16 = 1/8	8 | 4489 = 2244	8/16 = 1/2	8 | 8950 = 1119
3/16	3 | 5500 = 1833	9/16	19530
4/16 = 1/4	4 | 8325 = 5581	10/16 = 5/8	10000
5/16	5 | 7080 = 1416		
6/16 = 3/8	6 | 7760 = 1293		



44 7

50

2200

1100

2200

330.

44.

2200.

50 7

350.

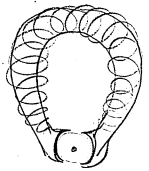
500 60 2000

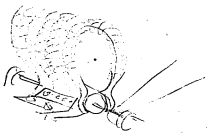
15 30.000

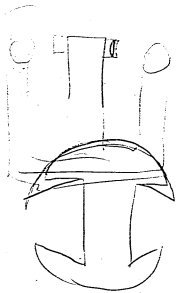
30

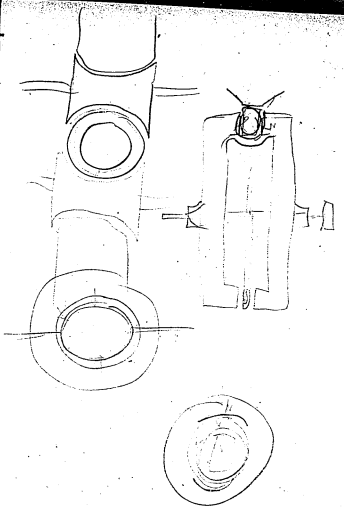
7 60 420. 10

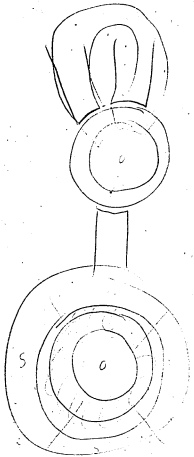
15 7 05







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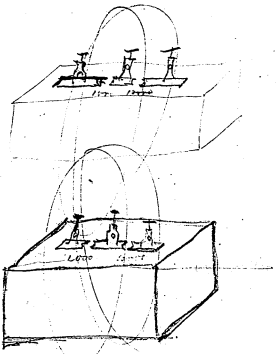
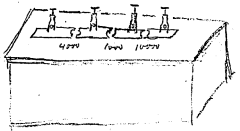
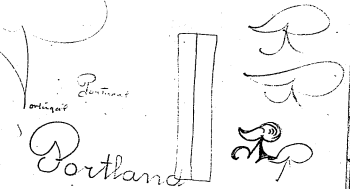
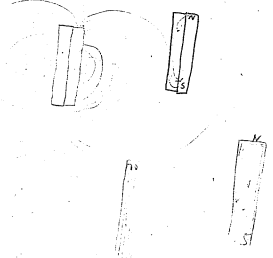


Pages 154 to 161. "Sketches & Calculation."
(Unimportant)







1 American Pittsburgh Pa.

$C = \frac{\varepsilon}{R}$ $\quad W = C^2\left(R_B + \frac{R_L}{n}\right)$

$\varepsilon = 1$

$W = C^2\left(R_B + \frac{R_L}{n}\right)$

$C = \frac{1}{R_B + \frac{R_L}{n}}$ $\quad C^2 R = \frac{\varepsilon^2}{R^2} R$ $\quad W = \frac{\varepsilon^2}{R} = \varepsilon$

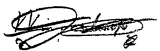
$W = \left(\frac{1}{R_B + \frac{R_L}{n}}\right)^2 \left(R_B + \frac{R_L}{n}\right)$

$= \frac{1}{R_B + \frac{R_L}{n}}$

$W \text{ in } B = \left(\frac{1}{R_B + \frac{R_L}{n}}\right)^2 R_B$

160

$$W_{\text{m lampes}} = \frac{1}{R_B + \frac{R_L}{n}} - \frac{R_B}{\left(R_B + \frac{R_L}{n}\right)^2}$$



$$W_{\text{m}} = \frac{\frac{R_L}{n}}{R_B^2 + \frac{2R_B + R_L}{n} + \left(\frac{R_L}{n}\right)^2}$$

$$= \frac{R_L}{n^2 R_B + 2R_B n + 2R_L n + R_L^2}$$

$$= \frac{R_L}{R_B^2(n^2 + 2n) + R_L(2n+1)}$$

$$R_B = 1$$

161

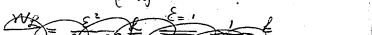
1.6.2

$C = \frac{\mathcal{E}}{R_B + R_L} = \frac{\mathcal{E}}{B+L}$ $\quad W = C^2(B+L)$

$W = \left(\frac{\mathcal{E}}{B+L}\right)^2 B + L = \frac{\mathcal{E}^2}{B+L}$

$W_B = C^2 B = \frac{\mathcal{E}^2}{(B+R)^2} B$ · One lamp

$W_L = C^2 L = \frac{\mathcal{E}}{(B+L)^2} L$



n lamps $\frac{L}{n}$ = resistances

$C = \frac{\mathcal{E}}{B + \frac{L}{n}}$

$W_L = C^2 \frac{L}{n} =$

$W_L = \frac{\mathcal{E}^2}{\left(B+\frac{L}{n}\right)^2} \frac{L}{n}$

$\mathcal{E}$ C $\quad W = C^2 R$ $\quad \mathcal{E} = CR$ $\quad W = \mathcal{E} C$

$C^2 = \frac{\mathcal{E}^2 \frac{L}{n}}{W}$ $\quad C = \frac{\mathcal{E}}{L}$ $\quad W = C^2 L$

$C = \frac{\mathcal{E}}{B + \frac{L}{n}}$ $\quad C^2 = \frac{\mathcal{E}^2}{L^2}$

$C = \frac{\mathcal{E}^2 n^2}{L^2}$ $\quad W = \frac{\mathcal{E}^2}{L^2} L = \frac{\mathcal{E}^2}{L}$

$W = \frac{\mathcal{E}^2 n^2}{L^2} \frac{L}{n} = \frac{\mathcal{E}^2 n}{L} = \frac{n \mathcal{E}^2}{L}$

$\frac{W}{n} = \frac{\mathcal{E}^2}{L}$

$C = \frac{\mathcal{E}}{B + \frac{L}{n}}$

$C = \frac{6}{B + \frac{L}{n}}$ $\quad W = C^2 \frac{L}{n}$

$W = C^2 \frac{L}{n} = \frac{\mathcal{E}^2}{\left(B + \frac{L}{n}\right)^2} \frac{L}{n}$

$L = 2 \quad n = 2$

$B = 1$

$L = 2 \quad n = 1$

$\left(\frac{1}{9}\right) 2 = \frac{2}{9}$ $\quad \frac{1}{}$

50 Ohms in lamps
1 Ohm in machine
$\mathcal{E} = 1$

$n = 1$

$\frac{50}{(510)^2}$ $\frac{50}{(510)} = H$ $\left(\frac{1}{R}\right)^2$

$\frac{50}{2}$

$1 +$ .169597 / 3.41514 / 2.28383

.0192

1.70757
1.70757
3.41514

$\frac{50}{2}$

$26\frac{1}{2}\overline{)150}$

1 Ohm outside 1 cell

~~[illegible]~~

.111 Ohm internal
$\mathcal{E}$ = 2 Daniells = 2 Volts

$C = \frac{\mathcal{E}}{R} = \frac{2}{1.11}$ = Quantity

Work = $C^2 R = \left(\frac{2}{1.11}\right)^2 1.11 \times 44.2$

= Foot lbs.

$\frac{44}{1.11} \times 44.2 =$ [illegible] about

Total 160 ft. lbs.

166

2 cells $C = \frac{\varepsilon}{R} = \frac{4}{1.22}$

$\varepsilon = 4$

$R = 1.22 = 1.22$

$W = C^2 R = \left(\frac{4}{1.22}\right)^2 (1.22)$ ~~4.92~~

$W = \frac{\varepsilon^2}{R} = \frac{16}{1.22}$ 44.2

1.20412
9.9136 · 10
1.64542
~~2.76318~~

579. ft lbs

log 33.000 4.51851
— 2.76315
1.75533

56. 6 H.P.

167

3 cells $\varepsilon = 6$ Volts

$R = 1.33$

log 36 1.55630
1.33 9.87615
44.2 1.64554
×3.07787...

1196

4 cells $\varepsilon = 8$

1.23
400
492.00

4.9
44.2

4.9
400
1960.00

5 cells

500

2500 ÷ 44.2 $W = \frac{\mathcal{E}^2}{12}$

5 | 2500 | 44.2

31 | 60.2 | 44.1

1.42

1324

80 → 710 000

500

6 cells

3 | 2000 | 44.2

31

31 | 44.2 | 1.42

1.42

2000

2840 | 284 amp

1 cell	160 ft lbs
2 cells	579
3 cells	1169
4 cells	1960
5 cells	2940
	1960
	880

March 12

The whole science of Heat. Phil should be expressed in Energy. A good way to express the would be with initial letters as H. E Heat E.E. Electrical energy be E.

250 × 2.39794
862 × .93551
5.33345

215500.

250
4 | 862000
21550

16 30

2000
125
25
215000

86:
25
430
172
21550

250
862
2
21500

21

250
862
2
1724
431
215500

250
862
104
312
416
2 | 448824
224412

1600
450.

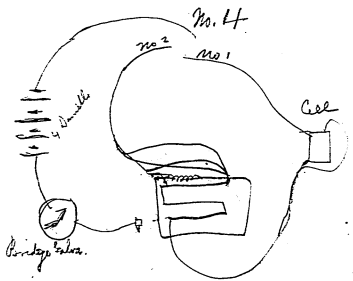
836,481
831,458

64,000.

668,848

836.461
831465

6691848
2509443
836481
3345924



$l_1 = 1360$

$a_1 = 1010$

$l_2 = 2960$

$a_2 = \cancel{950}\ 2010$

2010
1360
120600
6030
2010
2733600

1360
2960
16600
8300
12240
27720
4025600

4025600 − 1292000

950 − 1010

2010 − 1010
1000

27
1960
950
95

950
1360
57000
26600
950
1292000

4025600
1292000
2733600

1000) 4025600
2733600
1000) 1292000
1292

1010
2960
60610
1390
2022
2489600

2489600 − 2733600
2010 − 1010

2010
1860
120600
6030
2010
2733600

2489600
2733600
256000

2010
1860
1000

1000) 256000 (2
2000
1600
0
0

How do you get 13.000

How do you get that now?

$13.000 $13.000

13.000 $13.000

How do you get 13.000

$13.000

$13.000 $13.000

$13.000 $13.000

$13.000 $

1870

A lamp at three cents
per hour

$2.00 per 1000

200/200 x $ = 1 ct. per hour

1 ct. per hour

200/200 1 ct. per hour

1 cts. per hour

1 cts. per hour Francis
Francis R. Upton
Francis R. Upton
Francis R. Upton
Francis R. Upton

Francis R. Upton 161

June 22 1879

June 22 1879

June 22 1879.

June 22 June 22 June June
June 22 June 22 June 22
June 22 June 22 June 22

The elements of uncertainty are the following

1st Change in the train of the system especially in the memory. (You bet old boy

2nd Change in the solutions in the standard cells. If the saturation of the Zn. solution less there is for a small change 1% difference. Between standard cells and and ordinary Daniells there is a difference of 3%

3rd Change in the high resistance galvanometer, this seems to be the hardest to control for outside currents get into the line causing by without cause, probably thermo currents. Then if some one with a knife happens to short

near the galvanometer a deflection is obtained.

Then a slight lack of proportionality in the divisions.

4th Changes in the dynamometer. Jar affects the zero point Then rusting of the points seems to ~~increase~~ modify friction by holding dust. Perhaps an error enters into this instrument, by the change a capillarity of the mercury, so that for strong currents a slight constant error is introduced.

Besides this errors due to torsion of the wire irregularities

5th Change in the resistances from cooling. I have not been able to measure the magnet until two or three minutes after the current has ceased as the discharges is so great.

6 Change in the commutators I have not been able to make any allowance for this and propose to place the dynamometer in the machine shop so that I can watch the spark

7 Change in the speed of the engine this varies when running as light + 5%.

Slipping of Belts

Francis B. Crocker

m Francis B. Crocker

60465
4
241860
4
967440
4
3869760
4
15477760

1.547.776

96.744
96.744

5280

12093
2
24186
2
48372
2
96744

60465
4
241860
4
967440

96744

96.744 96.744
96.744 96.744
96.744 96.744
96.744 96.744
96.744 96.744

log 96.744

5280

4.98563

3.72253

1.26300

293

18.32 2

4

73.292

4

293.168

4 6046.5

1511.625

9

13604.6

4

54418.4

4

217673.6

217673.6

33766

15

5.33781

3.72263

41.227 1.61518

4

164.908

4

659.632

4

2631.8152

13604.6

9

122441.4

217673.6 5.33781

5280 3.72263

1.61518

41.22

25

15116.25

37790.625

15116.25

604650.0

5.78151
3.72263
21.55888

114.52
4
466.08
4
1864.32

37790.625
9
340115.625

5.53163
3.72263
1.80900

6414.1

15116.25

15116.25
4.9

74060.4

log 4.
antilog 5280

3.17944
1.69020
4.86964

0.60206
6.27737 −10
1.74907

56.139
4
244.556

15116.25
15116.25
1.66227875
15117.25
67796.375

192

64.1
56.1

73.3
64.1
9.2

56.1
6.8
493.
5.6
43.7

8

9.2

1.2

6.8
1.2
5.6

13
13
39
13
169
Comp 5-280

1511.625

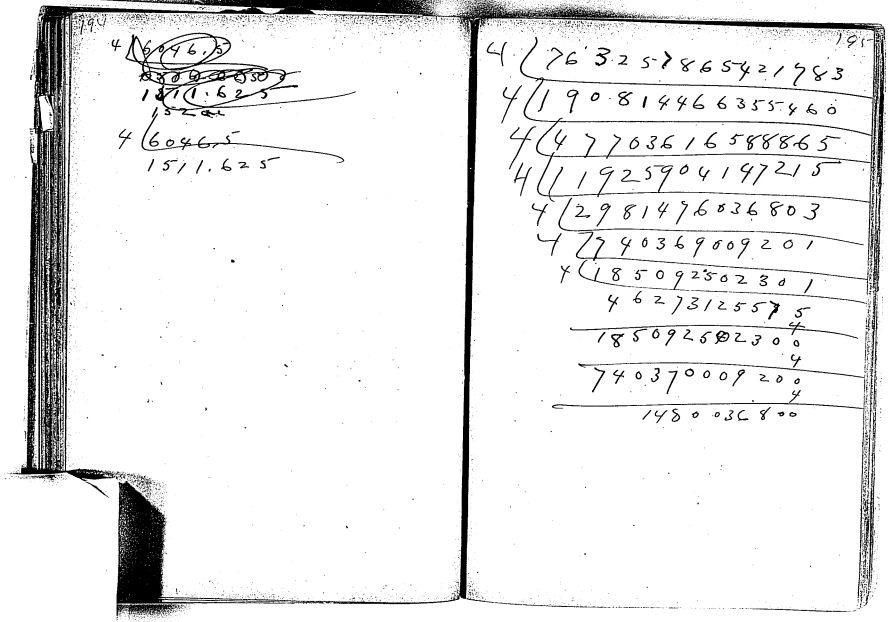
3.17944
2.22789
6.27737
11.68470
1.68470

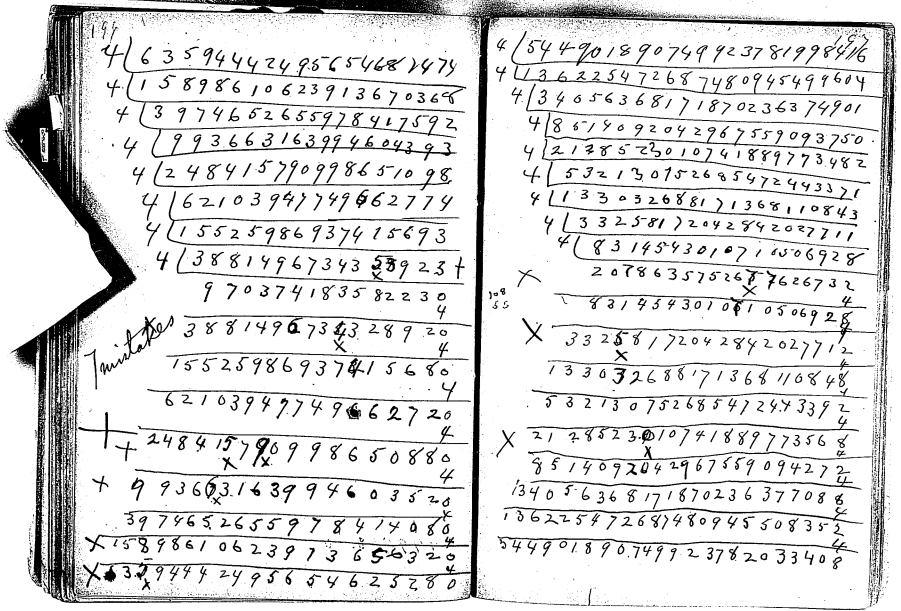
48384

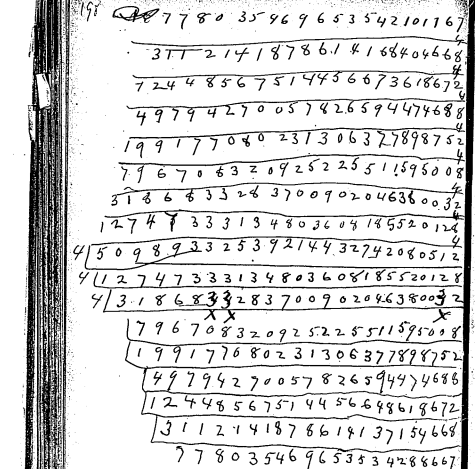
193

7.2
7.7
8.
9.2
9.4
17
17

3,17944
6.27737
9,45681
7,45681
1,23045
1,23045
1,91771







1 6558.1

81.4

5280

5280

5441 8.4

4

5280 | 217673.6 | 41.22

21120

6473

5280

11930

10560

13700

10560

3140

7558.1
10581.4
13604.6
16627.8
19651.6
22674.0
25697.4
28721.1
31744.9
34768.7
37791.9
40815.2
43838.4
46861.7
49885.0

30333
30232
30232
30232
30238
30234
30234
30237

1 3
4 5 2
9 7 2
16 9 2
25 11 2
36 13 2
49

15111625
64
60465000
90697500
96744.000
15111625
81
15111625
1209.3000
(22441.625

15111.625
49
136046250
60465000
74069625
96744.9
74069.5
22674

11/6

66046.5
151116.25
151116.25
151116.25
1677903.75

11
15111625
36
90697750
45348875
544185.00

15111.625
121
151116.25

151116.25
151116.25
151116.25
151116.25
151116.25
121 0
151116.25
30232250
151116.25
18290625

13/8

13
13
39
13
169

1511.625
169

1829061
1511625
317431
302314
5

1/

log 1511.625 3.17944
Comp 5280. 6.27737
9.45681
1.45681
2.15836
1,61517 7.16

41.22

1.45681
13 1.11394
13 1.11394
1,68469

88.3 8

24

1.45681
1.14613
1.14613
1,74907 7.73
59

56.11

1.45681
1,17609 830
1,17609 57
1,80899

683
16

1.45681
1,20412
1.20412
1,86505 53

73.29 7329 8.88
2441
8835 888
17

1.45681
1.23045
1.23045 84.67
1,94771 73.29 57
1143.8 945

945
18

1.45681
1,25527 35
1.25527 2455
1,96735

92.75
8274
1001

19
103.2
1.45681
1.27875
1.27875
2.01431

1.45681
281.44716
1.44716
2351.13

20
114.5
1.45681
1.30103
1.30103
2.05887

2245
561
4
2244

21
126.2
1.45681
1.32222
1.32222
2.10125

22
135.4
1.45681
1.34242
1.34242
2.13165

23
151.4
1.45681
1.36173
1.36173
2.18027

24
164.9
1.45681
1.38021
1.38021
2.21723

1.45681
32 1.50515
1.50515
2.46711

293.1
293 1
9
26379

1.45681
401.60206
1.60206
2.66098

458.1
114.6
4
4584
4
18356

1.45681
481.68124
1.68124
2.81929

659.6
4
2638 4
164.9
4
6596

1.45681
401.90309
1.90309
3.26990

1833
1848

1.45681
1.98227
1.98227
3.42135

2636

1965

1389 3.14270
1389 3.14270
4 6.28540
.166206
5.68334 .4823

13
13
39
13
169

.81 .9
.64 .8
.49 .7
.36 .6
.25 .5
.16 .4
.09 .3

694 0000

1000000
482300

1965

982.5
961.5
9
924.5
907.

13

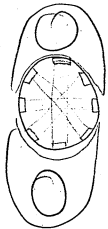
E. M. F

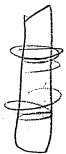
100 100 100 100
7

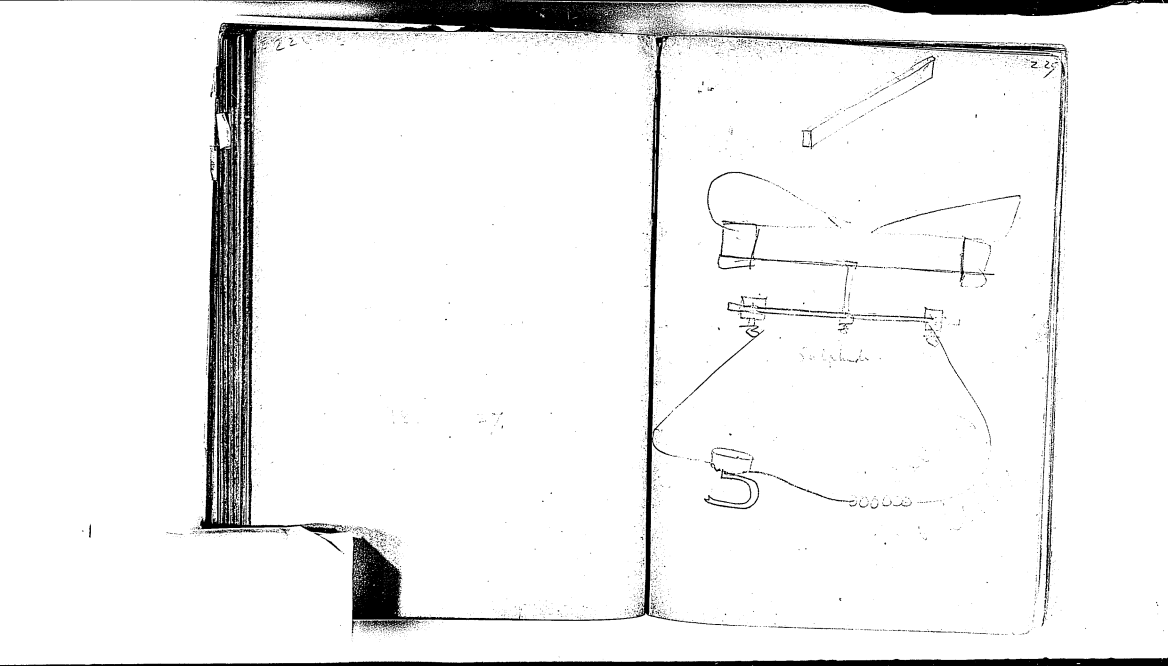
1.972 mg

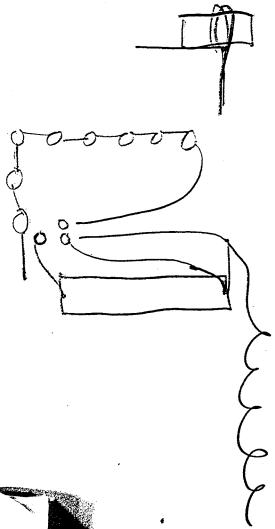
60 | .001972 Grammes
.0000328 second

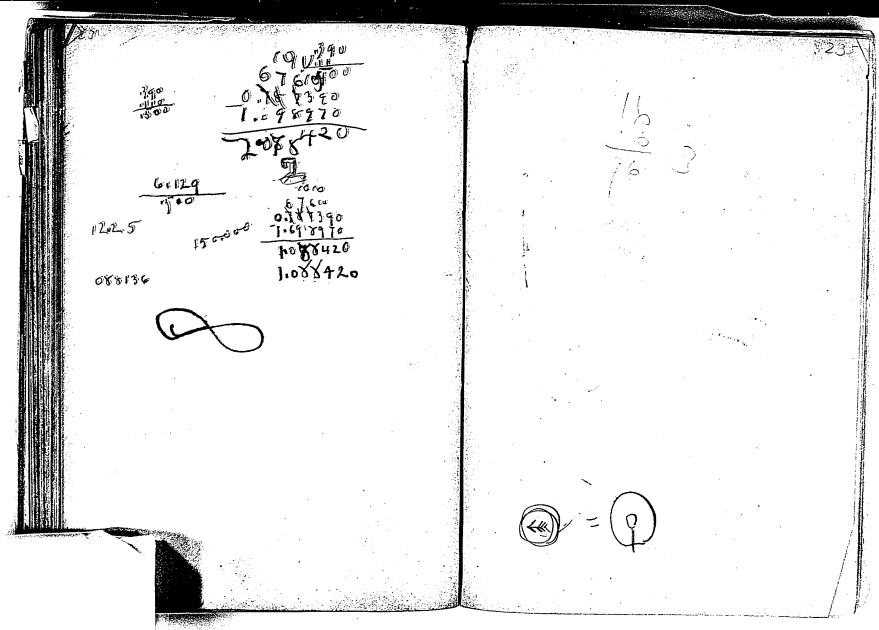
.0328

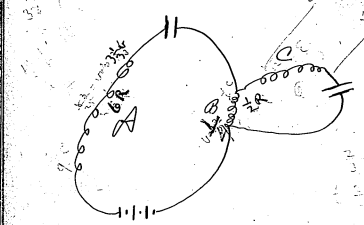










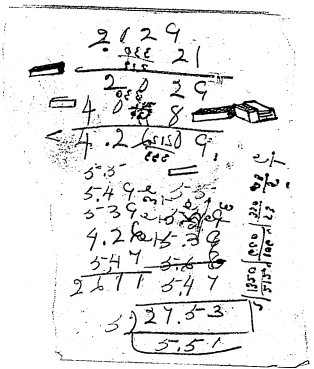


I make the deflection from
4 cells = 10.8 2.7 per cell
A = 6 Ohms
around which I have a
deflection of 8.3

I make the deflection
around ½ A or 3 Ohms
= 300 then the deflection
from around B was 49
C being opened.

Produce Equation
C open deflection around
B made equal to 330
C closed deflection around
B = 311
and around C = 212
6 Ohms
Required the current
in Webers ~~around~~ through
C

[ITEM FOUND IN BOOK]



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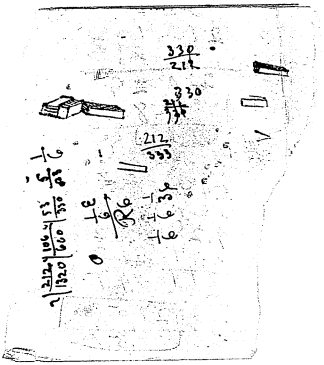
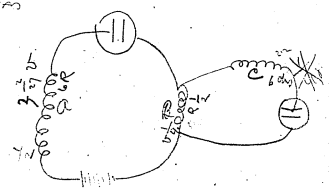




X = webs.

$\mathcal{E} = \frac{\mathcal{E}}{R}$ $\mathcal{E} = \frac{1}{2}$ $R = \frac{1}{2}$

$C = \frac{\mathcal{E}}{R}$ $C = \frac{1}{2}$

$\mathcal{E} = CR$ $R = \frac{1}{2}$

$\mathcal{E} = \frac{1}{4}$

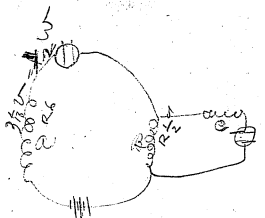
$3 : X :: 3\omega : 49$

$\frac{1}{2} : X :: 330$

Let x = webers

$330 + 6x = 212 \div \frac{1}{2} x$

$330 + 6x = 212$



$\frac{V3}{R6} = \frac{1}{2} W$

21) $\frac{5}{2}$ (3) $\frac{4}{21}$ $\frac{1}{13}$

$\frac{43}{147}$ 2

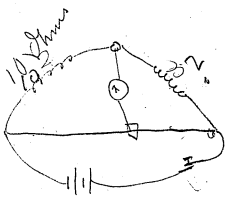
3 : x :: 300 : 49

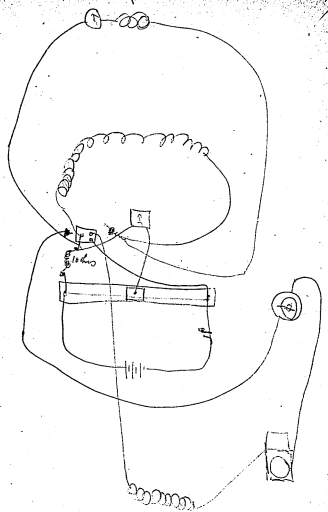
$\frac{147}{300}$

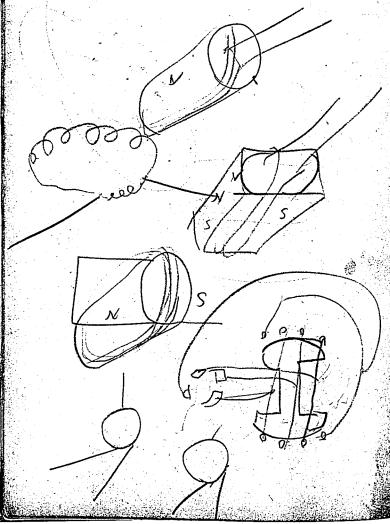
~~Let x =~~

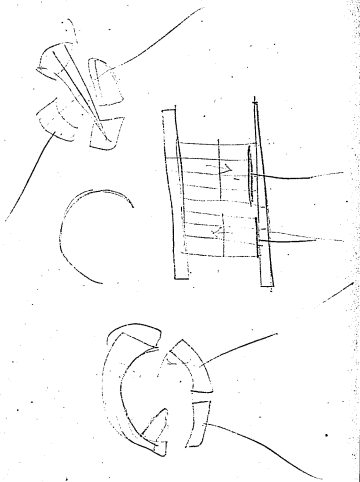
4w · x = one weber of current

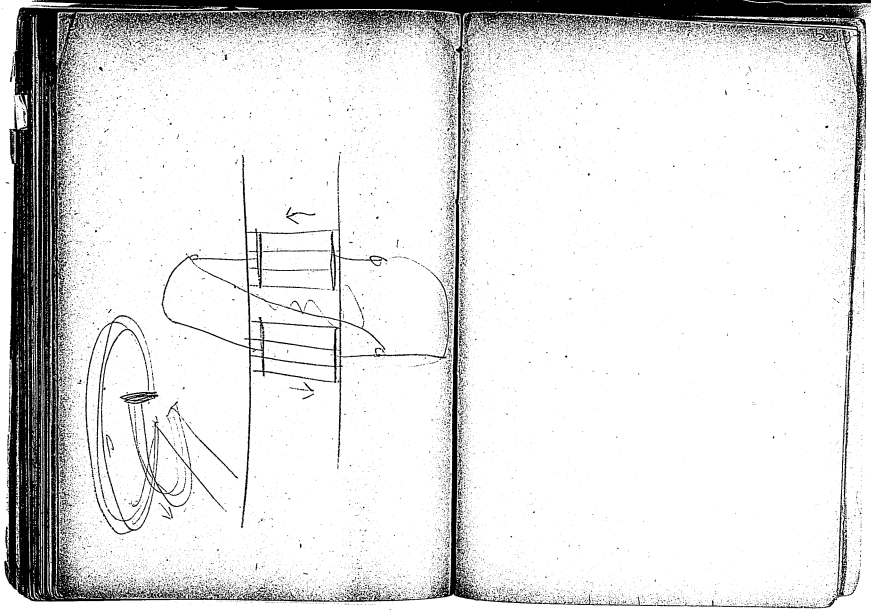
6x · 5

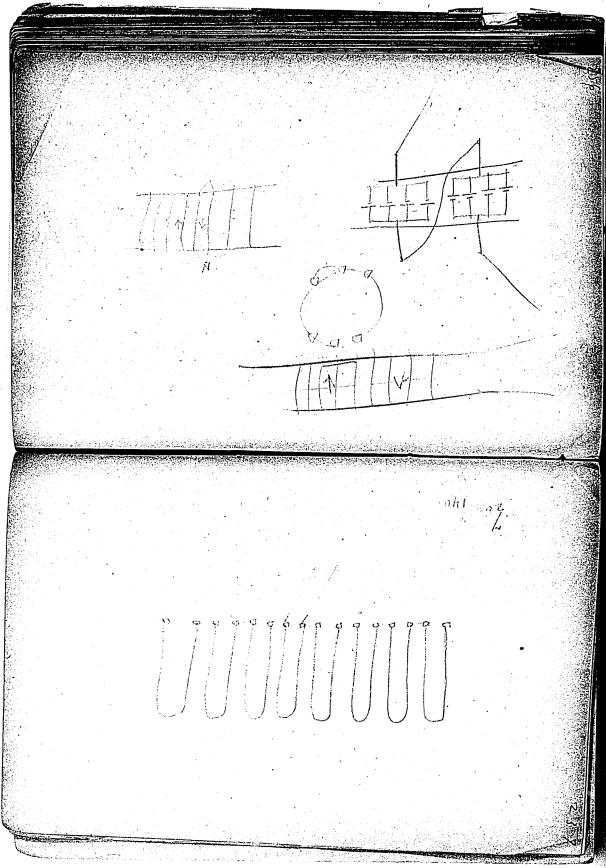


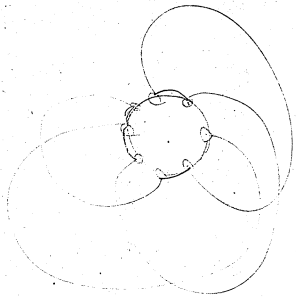



N
N
S
S
N
S









202

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1 1/2
1 3/4 96 480

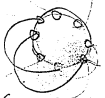
2220 4 8880 384 9264

2 2220 36484

96 4 384

96 4 96 4 288

12096 4 48384



1.6744
19 1.2788
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2.5) 16
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17064

22870
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2130
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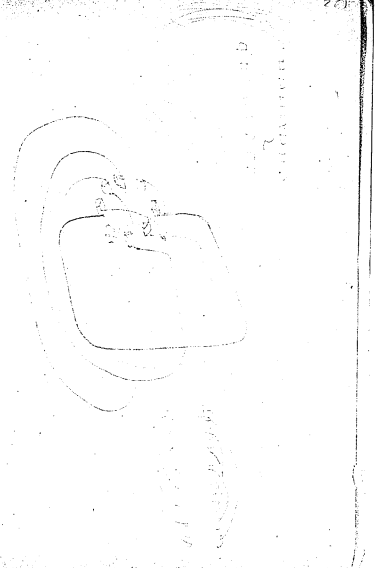
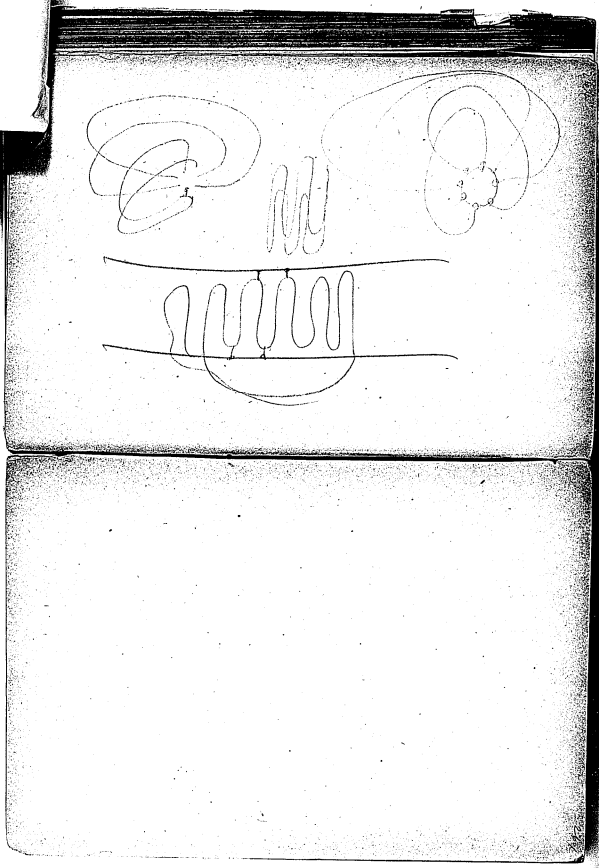
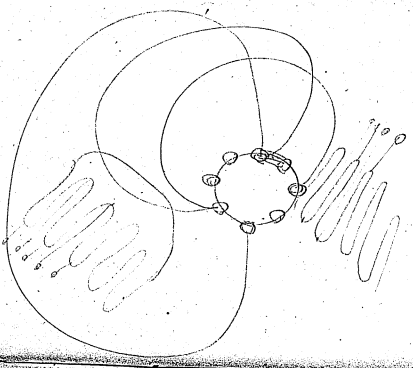
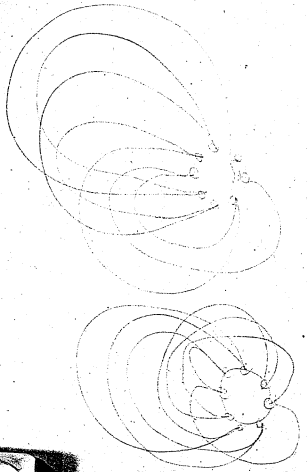
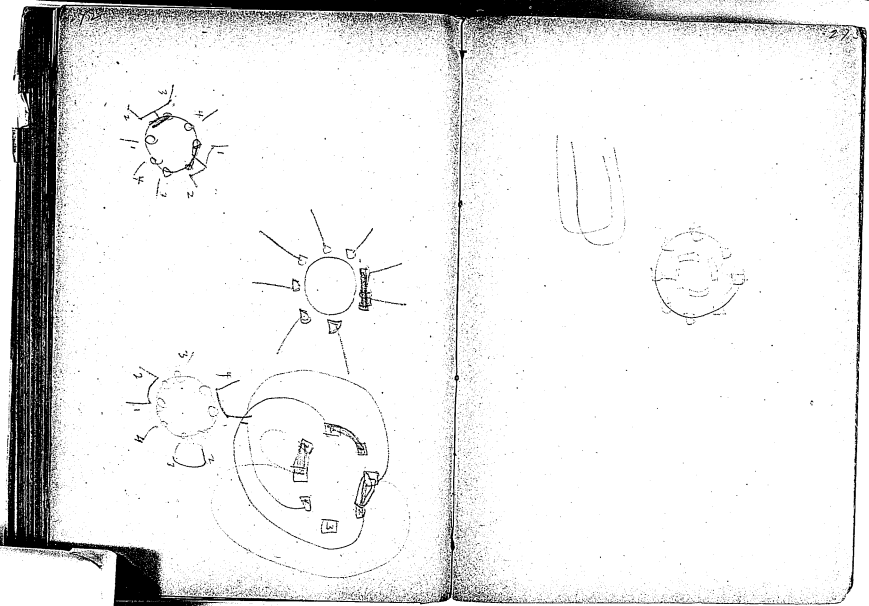
18900
1940

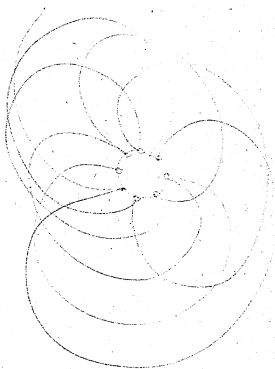


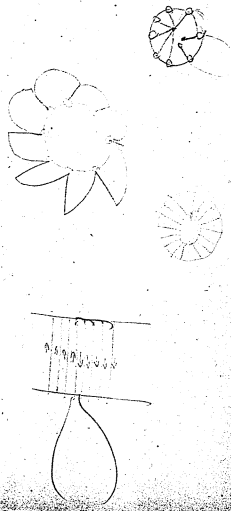


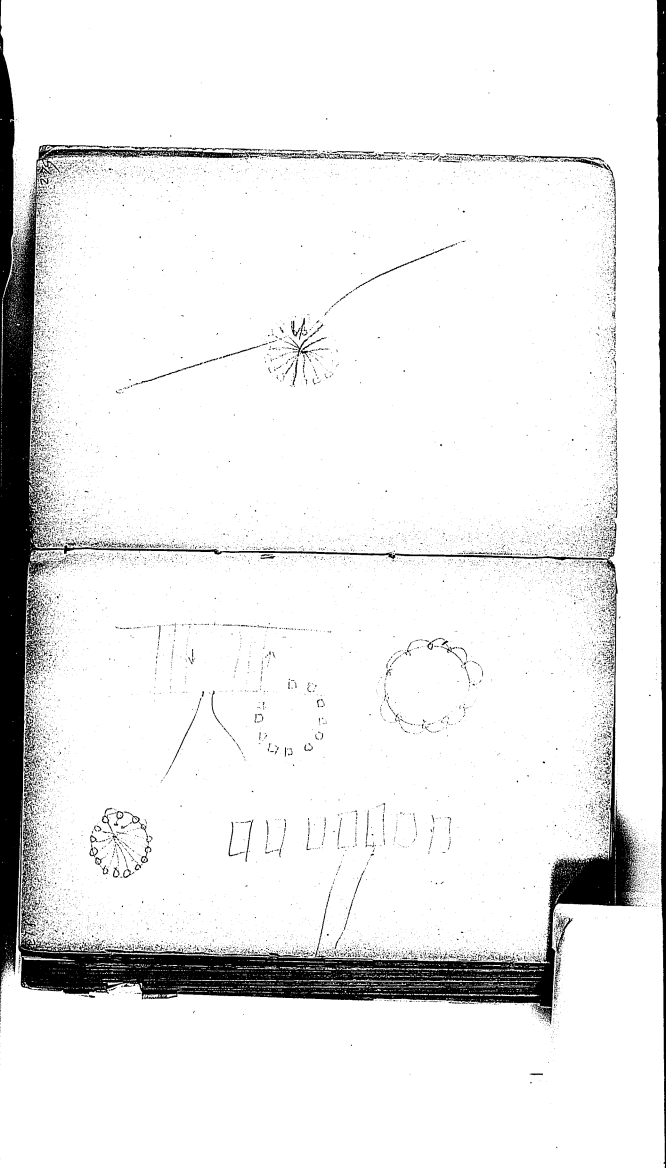


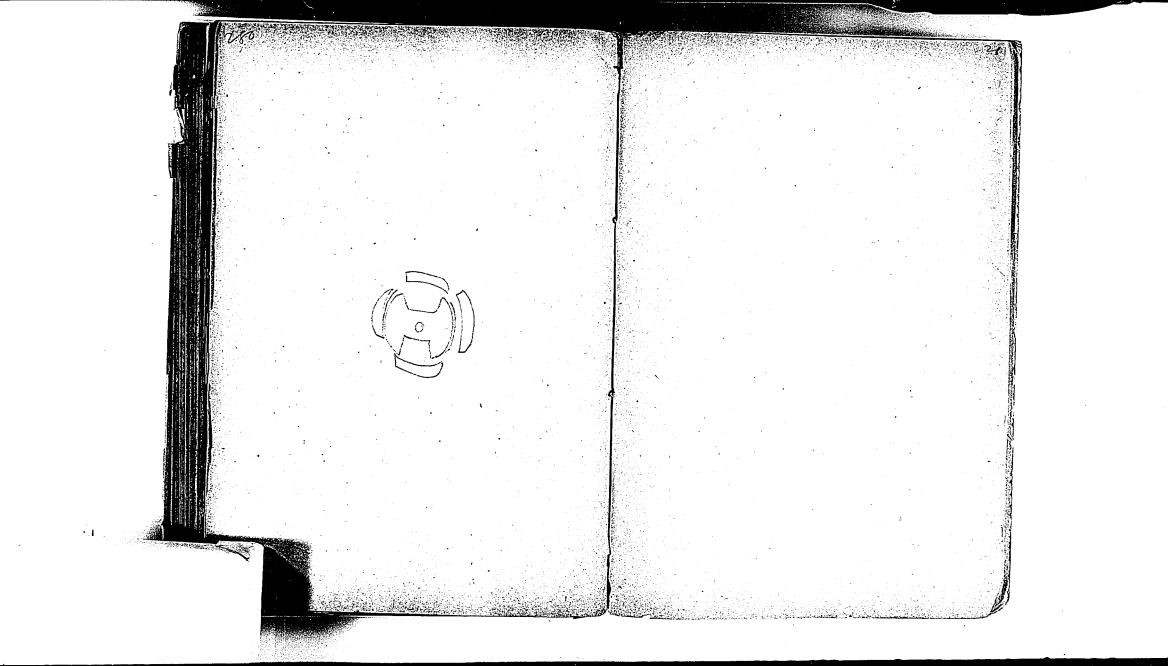


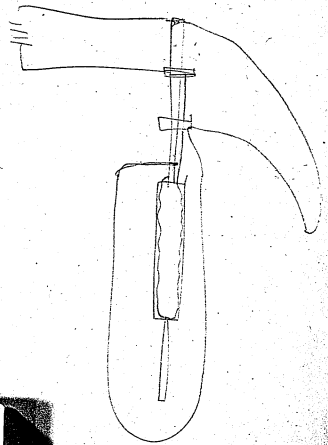




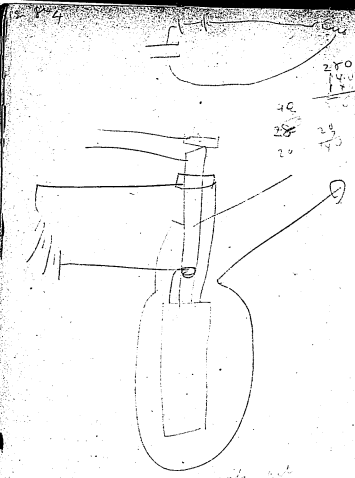








$\frac{27}{108} = \frac{1}{4}$



876:124 :: 10 : ?

876) 1240 (1.
876
364

364 : 876 :: 271 : ?

Menlo Park Notebook #12 [N-78-12-20.1]

This notebook covers the period December 1878-January 1879. Most of the entries are by Francis Upton. A few are by Charles Batchelor. All of the material relates to experiments on electric lighting. Included are notes and calculations on filament experiments; notes, drawings, and calculations on generators; and calculations on electric power distribution systems, with comparisons to gas lighting. On page 198 is a table on the cost of electric light, calculated for varying numbers of lamps per day, month, and year. The book contains 284 numbered pages.

Blank pages not filmed: 46-47, 260-261.

M012

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120 BROADWAY, NEW YORK.

Case [illegible] of

GENERAL ELECTRIC

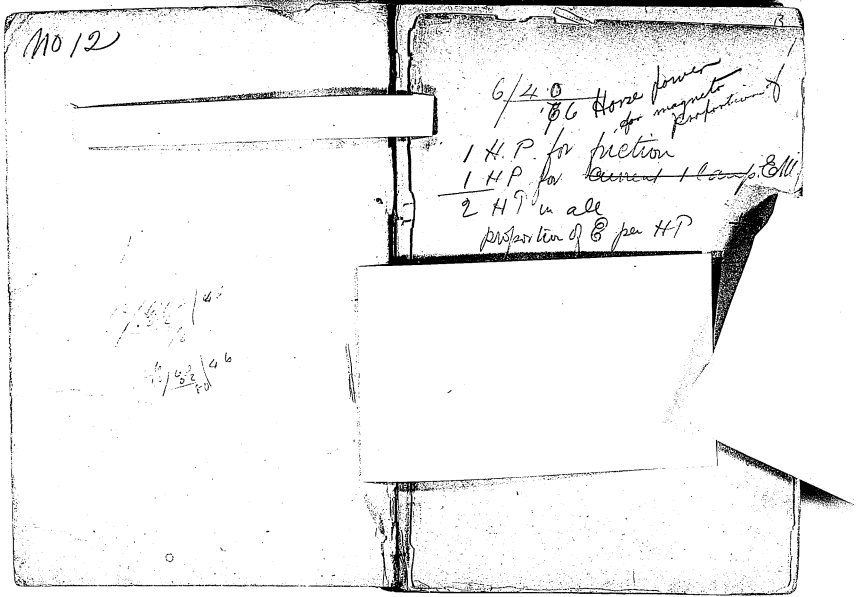
[illegible]

[illegible], 189[illegible].

6/40 Horse power for magneto perforation of
.86
1 H.P. for friction
1 HP for [illegible]
2 HP in all
proportion of 8 per HP 1/2 E

Double
6 ub
AJ

0.0 000
0 000
00 00
0 000

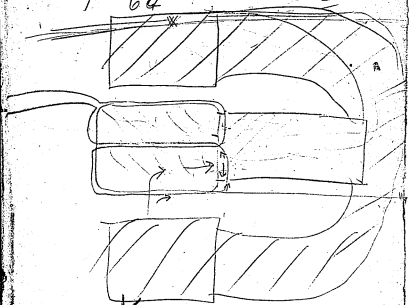

No 12
6/40 Horse power
.86 for magneto perfection
1 H.P. for friction
1 H.P for current
2 H.P in all
proportion of 6 per H.P

2

8 : 11 5- 10 : 13 : 5-

5 | 50 / 64

10 | 65 / 6 1/2



Attempt at
iron commutator

Electric light

Dec 20 1894

Friction preventer — Charles Satchell

Mt U. Force

If you put a magnet over the top of a shaft & lift it up and take the weight off it will it run longer with a given amount of energy?

	Weight & thread Without magnet	With
1 —	6 ½ seconds —	9 ¾
2 —	7 ¼	9 ¼
3 —	7 ½	10
4 —	8	9 ¾
5 —	8	10
6 —	8	10
7 —	8	10 ¼
8 —	8	10 ¼
9 —	8 ¼	10
10 —	8	10 ¼
10	77.50	10 99.75
Mean	7.75	Mean 9.975

Electric Light Dec 20th 1878

Friction fermentum of

Large magnet
1/32 from shaft
runs down in 10 seconds

~~1/16 from shaft~~ In this
case the magnet held it
up itself so that to feel the
shake in shaft you have to
pull it down

Same magnet 1/2 inch from
shaft 1 — 9 1/4 seconds
2 — 9 1/4 —
3 — 9 1/2 —
4 — 9 1/2 —

Same magnet 1/4 inch from shaft
1 — 10 — 4 — 9 —
2 — 10 3/4 — 5 — 10 —
3 — 11 — 6 — 10 1/4 —
4 — now all the bearings

Friction, Prevention of

Same magnet to work
away where you can push
shaft to top or bottom
& then run for
20 seconds or
2½ times the length of body
without magnet

Running 45-0

Gramme machine Ex with Lath

Gramme machine 3 cells

~~cells~~ Carbon Batt. 45°

Bradley. When assisted

is, turned in same direction,

the current can be brought

to zero and then there

is no sparks by turning it

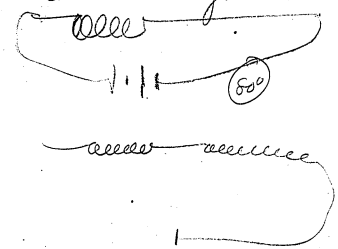
further deflection in the

opposite direction.

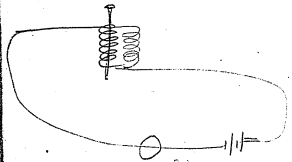
80°

80°

Current diagram



Current diagram



10 10

16

-0 11

12

$\frac{1}{4}$ 36

12
6
6 2 3 3/12
3 4 1 1/2
8 3/4
16 3/8
32 3/16
64 3/32

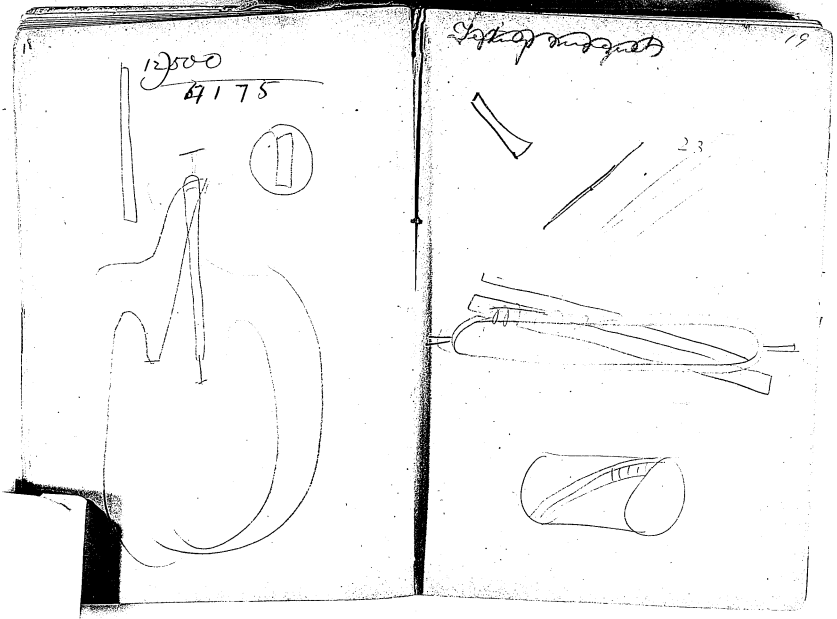
180
40

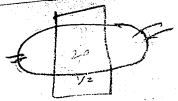
~~6400~~

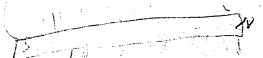
2000 100'

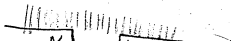
50000 sq

110000

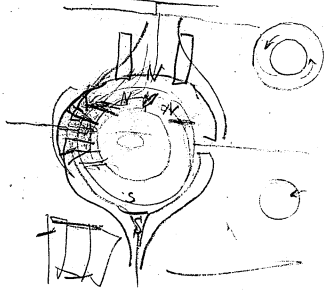

12500
47175
23

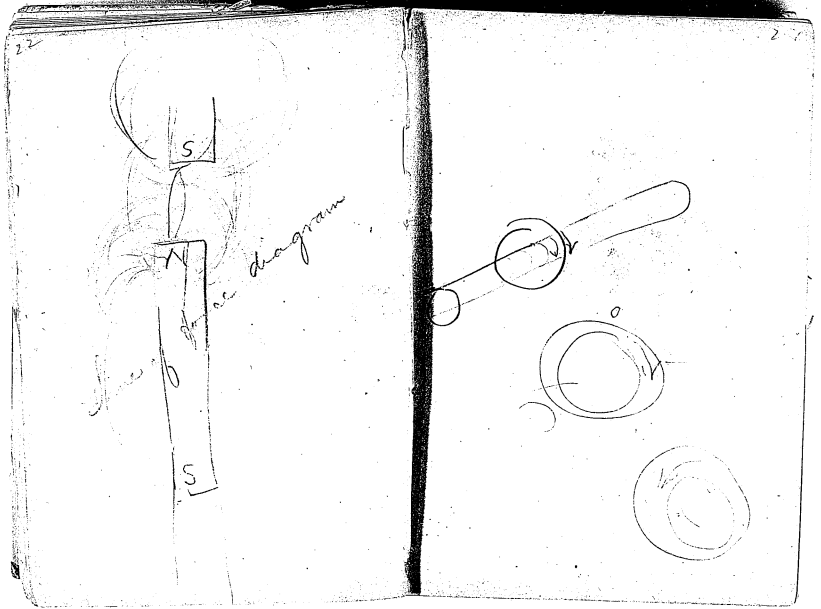






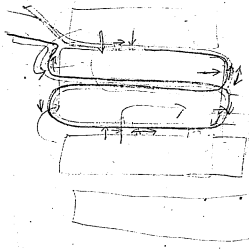
Gramme diagram

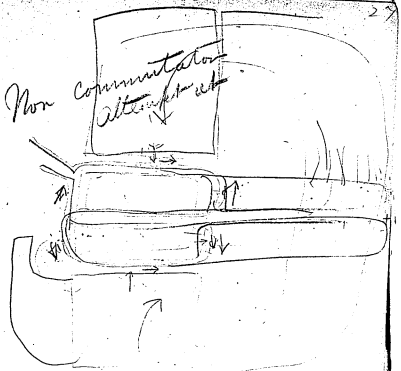



S
N
S

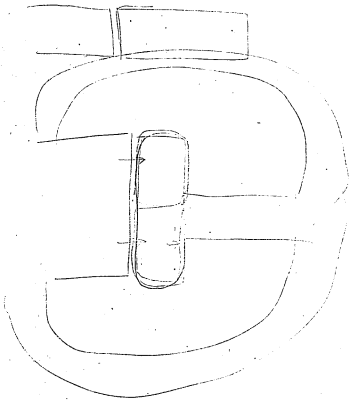
Non commutator attempt

Non commutator attempt

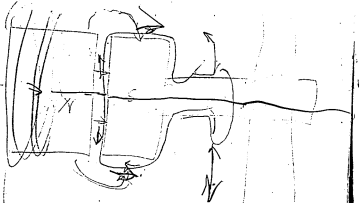


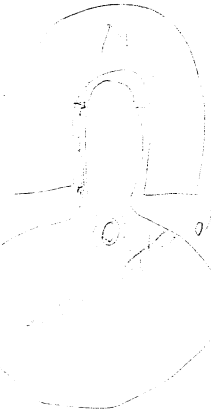

Non Commutator
alternator

Non Commutator attempt 2



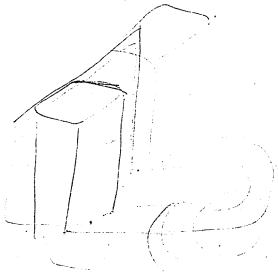
Non commutator, attempt at.

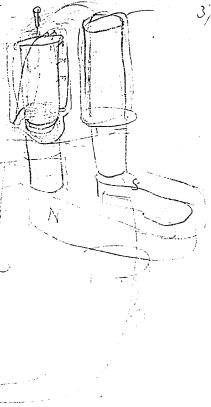




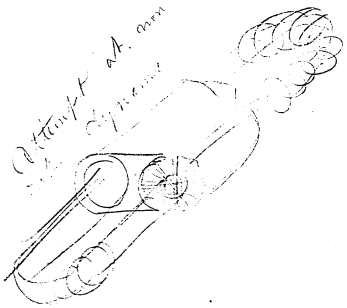
Non commutative, attempt at ark.

Dynamo machine.
N
S

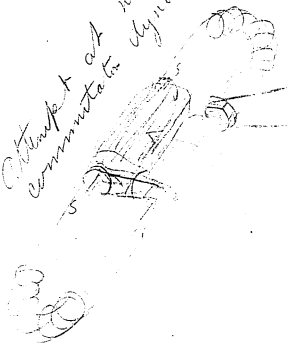


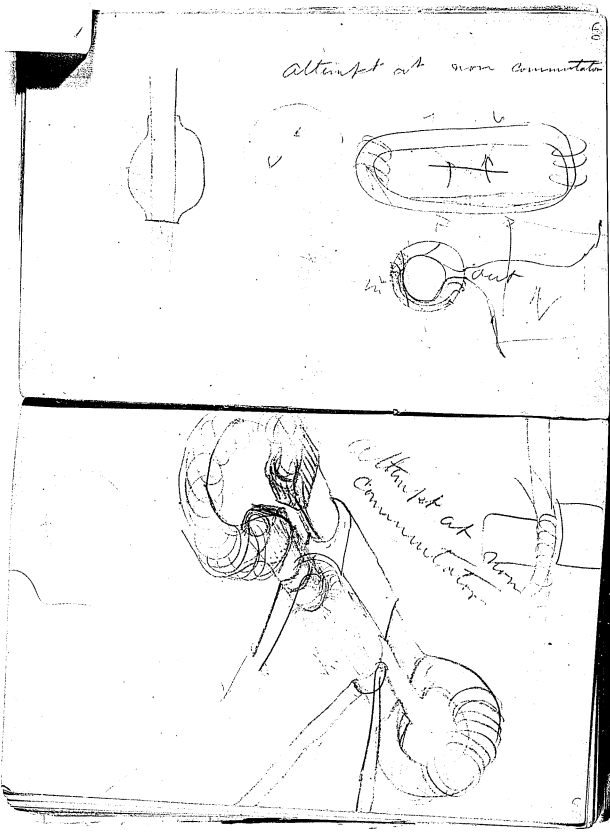


Attempt at A. arm [illegible]
Appearance



Attempt at A. arm
commutator
Appearance.

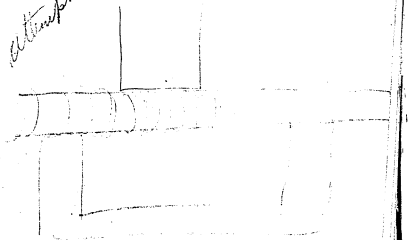


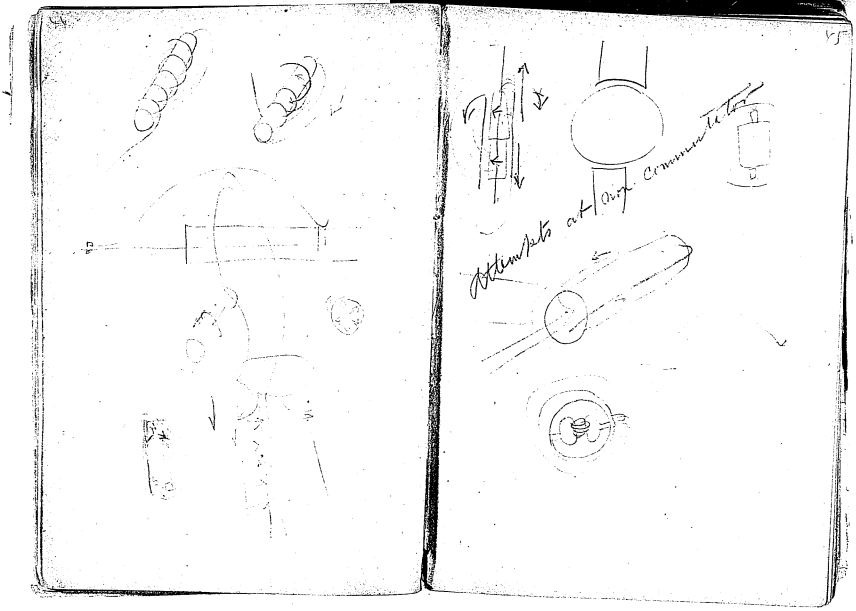

attempt at arm commutator

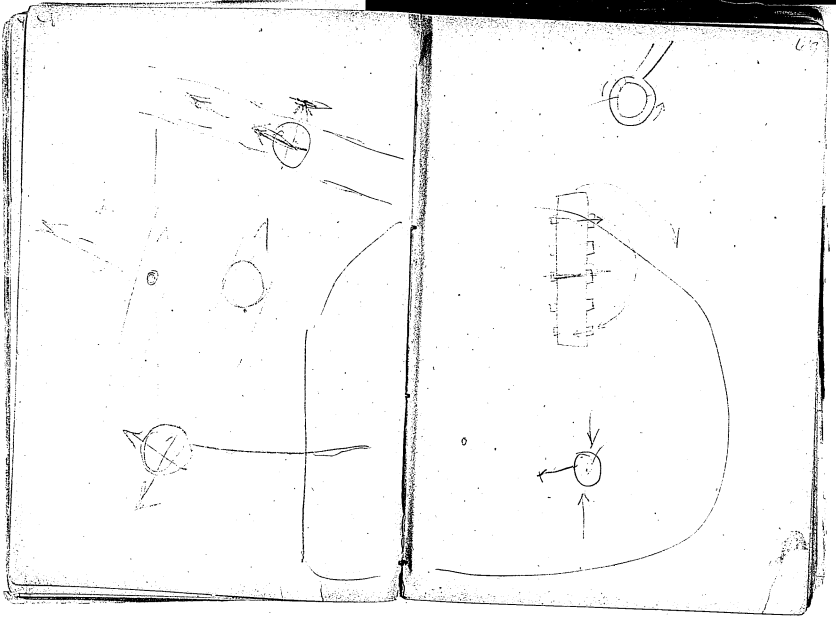
42

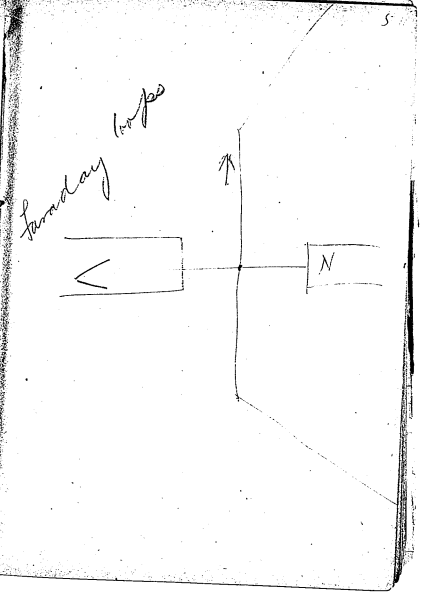
43

attempt at math comments

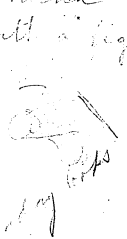


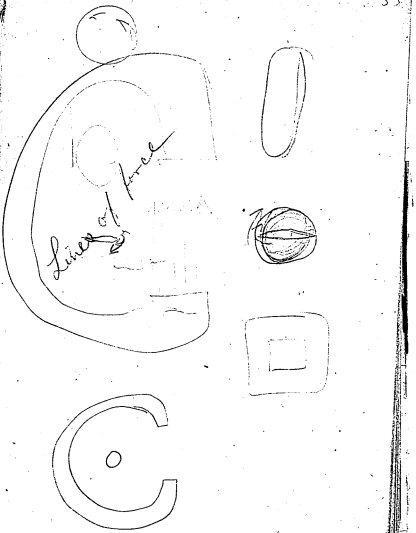


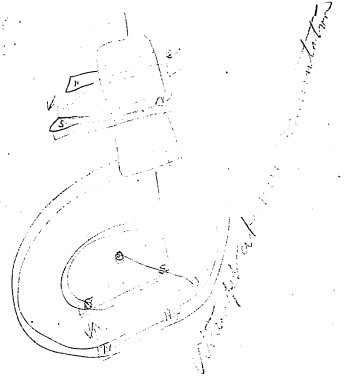


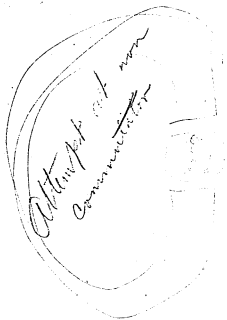

Faraday
N

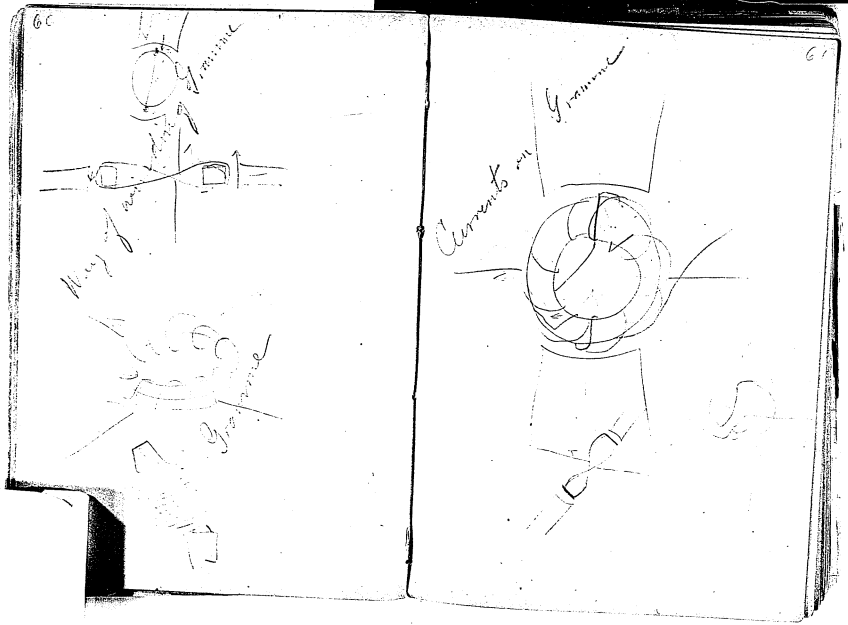
Wound a magnet
with a figure 8
marked

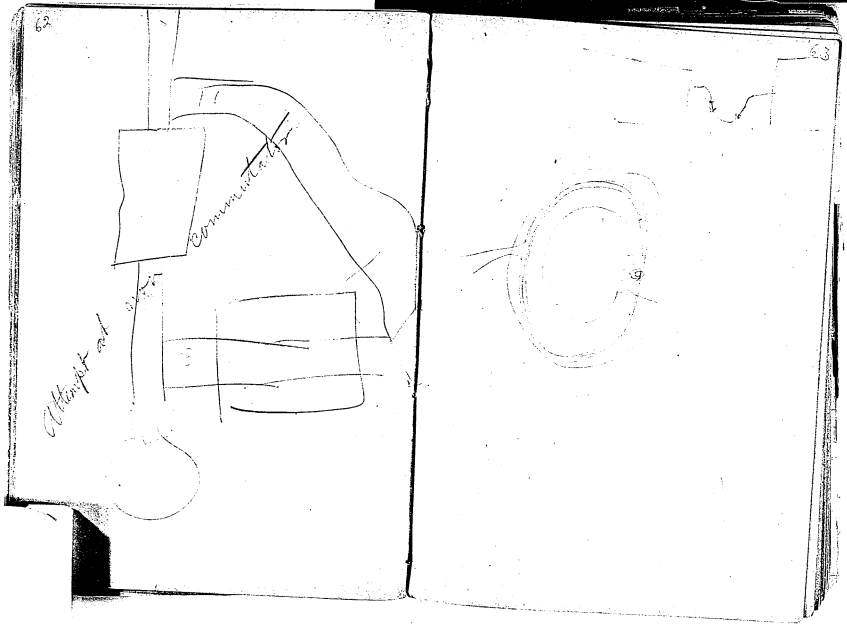


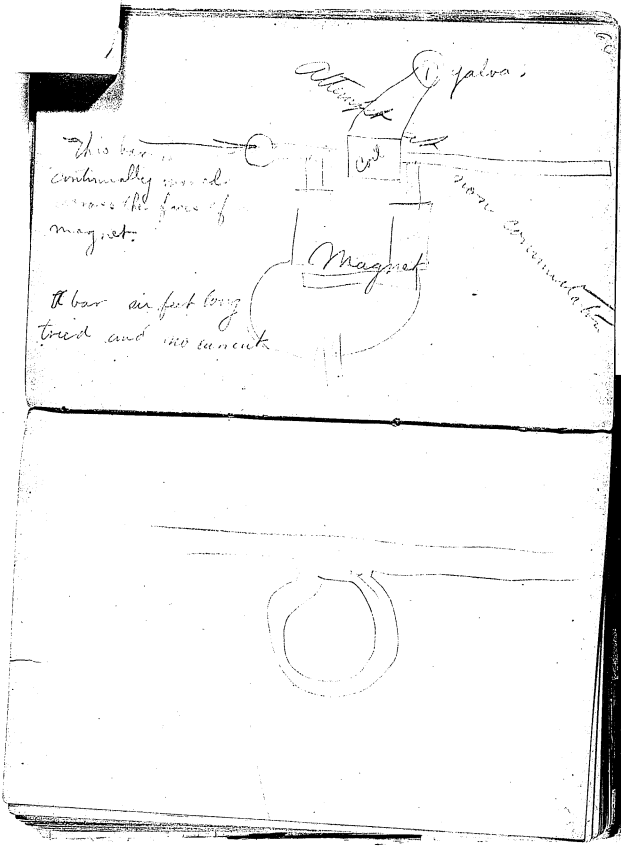






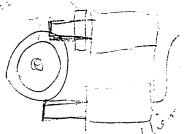



62
63
Commutator
Attempted sketch


galva.
This bar
Magnet
A bar air fast long
tried and

66

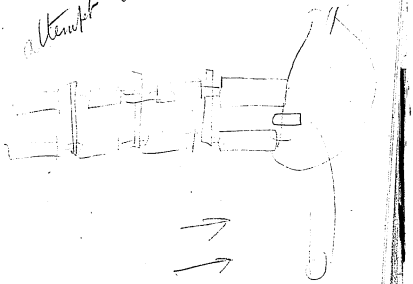
Attempt at a machine for multiplying magnetism



Attempt magneto

67

Attempt at non-commutator



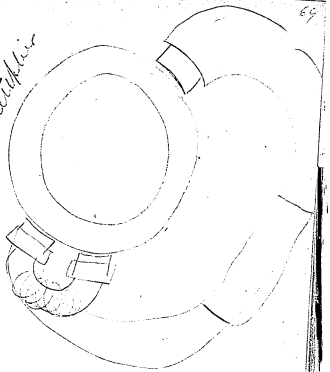
Attempt for Vidyarthi multiplier

12)500(41.25
48
20
12
80
72
60

15)500
45
50

16)500(
32
500 31.25
45
20
16
96
32
80
80

Attempt for Vidyarthi multiplier



Rt. Spinal Resistance

Cold @ 4.6 Ohms Collected

Warm 5 Ohms

Red : 9.3 Ohms

White 12.

4.6) 12 (2.6
92
280
276

Red 5° 5 Red
9.3 Ohms

9.3

51° 12 Ohms White

Cold

5.6

38.0 Red 4 Cells

9.6 Ohms

Increment 9 cells
5 2°

13.5 Ohms

9.6 Red

13.5 White

Heat = C^2R 35° Rest

.60

.12

.61

12

7.32

.6
9
2.4
9.6
12.0

E in 36° = .78

in 52° = 1.27

log 1.61 = .2076 (2) .1038

1 Internal

1 External

100

100

.178
.178
128
546
.60648

White $1.61 = C^2$

6
9
54
13.5
18.9
1.61
189
1134
1890
30.429

Dull Red 37°

5.35

3 cells of Carbon battery

White 54°5 7 cells of

7.35 Ohm

16
7.35
8.65

10 Cells through 7.35 in
coil and 8.65 resistance
brought it to vibrate.

5.3 5
2
16.0 5.

7.3 5
3
22.

5.35 / 7.35

Carbon .6. Ohm

$(B + R) = B$ D = deflection

$B + R$, ~~###~~ Resistance D_1 = deflection

$R : B + R :: D_1 : D$ Ayrton Collaud

$D, B + D, R_1 = D B$

$B = \frac{D_1 R_1}{D - D_1}$

$D = 42^0$ $B_1 + R$

$R = 2$ Ohms

$\tan 42^0 = .90$

$R_1 = 2$

$\tan 27^0 = .51 = D'$

$.90$
$.51$
$.39$

51
2
$39 \overline{)1.02} (2.6$
78
240
234
60

Red

In 4 cells give 38°

Coil 9.6Ω Resistance Pt steel

Heat = C^2R

tan 38° .78

$(.78)^2 = .61$

each cell

.61
12
7.32

.6
4
2.4
9.6
12.0

White Heat

9 cells give 52°

Coil 13.5 Ohms

Heat = C^2R

tan 52° = 1.27

$(1.27)^2 = 1.56$

1.27
1.27
889
254
127
1.56 29

.6
9
5.4
13.5
18.9

18.9
1.56
1134
945
189
29.484

7.32) 29.48 (4
29.28

Jan 10 1919

79

80

Red 37° 3 cells

Coil 5.33 ohms

$\Omega^2 R$

9.877
9.877
19.754
.854
20.608

.6
3
1.8
5.35
7.15

.408 = long 4.06

White 54.5° 7 cells

Coil 7.35

10.146
10.146
1.060
21.352
1.352

6
7
4.2
7.35
11.55

22.5

4.06) 22.5 (5
203
20

81

82

2 cells temp. ok red

4 cells 38°

Coil ~~Tab~~ 9.6 9.6

~~9.6~~

Log 38° 9.892

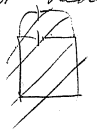
9.892	9.892
9.892	9.892
.698	.982
20.482	20.766

83

9 cells 52°

Fr3	10.107	10.107
Coil 13.5 log 135	10.107	10.107
	.032	1.170
	20.246	1.384
~~Log 13.5~~	.482	.766
	.464	.618

4.15 more heat given off at mean distance than the Red heat.



84

2 cells 36°

Civil 4.9

C =

log tan 37° 9.877 log tan 54.5 10.146
9.877 10.146

log 5.35 .728 log 7.35 .866
20.482 21.258
.482
.776

5.96

85

2 cells

6
14.7
log 4
9.8

C = 6 / 4.8 + 4.9

2 nine cells
4.9

86

Final use of Jan 10

Coil 7.35 Ohms

Rise 5

Girth 4.8 17.15

θ = 18°

9.5511
9.5511
.886
19.888
7.74

Coil 5 Ohms

Rise 14

Girth 4.8 24.8

9.288
9.288
.698
19.274

θ = 11° 1.88

87

Jan 10 Short not known

18 11
18 11
144 121
18 5
324 605
735
1620
972
2268
2381.40

4 times more work for meander wire than for rod

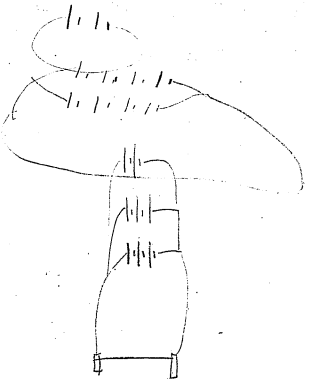
605) 2381 (3.9
1815
5660
5445
1150

1.88 (8.888
.274
614

4.1

Red new Spiral
5.2 Ohms

Incandescent
7.3



90

11 ⟌ 3.3

.3

8 ⟌ 4.4

.55

10. ⟌ 4.4

.44

12 ⟌ 4.4

.36

14 ⟌ 4.4

42

150 mins very dull red 91

D = 6° 15'

Dull red

D = 12°

R = 69

Again

D = 11° 30

R = 7 Ohms

Dan R

92

~~Right red~~
Orange red
13° 15'
7.7 Ohms

13° 15'
7.7 Ohms

~~12/5000~~

93

Yellow in the dark
N = 15° 45'
R = 8.4 Ohms

N = 16°
R = 8.9

94

Bright Yellow

$\Delta = 13°$

$R = 9.2$

95

Red same as that of iron lamps.

$\Delta = 14° 25'$

$R = 8.8$ plus

9,4100
9.4100
.9030
19.7230
1.7230
1.3894
2.16 .3336

96

14 cells full [illegible]

A = 20° 30'

R = 1[illegible]

20° 15' 9.5669

9.5669

1.0606

2.1944

D = 20°

R = 11.9

.1944

T 7230

2.96 .4714

.1944

T 3894

.8050

6.39

97

Lowest red

Δ = 11°

R = 6.49

9.2886

9.2886

.8122

1.3894

T. 3894

98 Of Wire
Another red of spirals

12° 15'
7.4

9.3367
9.3367
.8692
.19426
$\bar{1}$.5426

Incandescent
$\bar{1}$.1944
$\bar{1}$.5426
.6518

4.48

From spiral red

21° 30'

5.3 ohms

9.5953
9.5953
.7242
.19148
$\bar{1}$.9148

$\bar{1}$.1944
$\bar{1}$.9148
.2796 = log. 1.9

$\bar{1}$.9148
$\bar{1}$.5426
.3722

log 2.35

Spiral Rd 2.35 times
wire Rd

wire mean 4.48 times wire
Rd

2.35
@1.9
2005
235
4.355

.13 diameter of a spiral of Pt wire
1/2 inch long

0.010 wire

.13 1.1139
3.141 .4969
.5 1.6984
699

Rt. Spiral Jan 15 1921
2 cells dull red

D = 13° 30'
R = 3.1

9.3803
9.3803
0.4913
---
19 25-19
---
1. 25-19

D = 4 cells
R = 2.66

12

D = 35°
R = 34.96

9.8452
9.8452
.6954
20.3858
−.3858
1.2519
1.1339

13.5

Still Red
Offset 14°35'
Result 3.36

9.4126
9.4126
.5263
19.3515
−1.3515

6.78

D = 29°30'
R = 4.76

9.7526
9.7526
.6776
20.1828
−1.3515
.8313

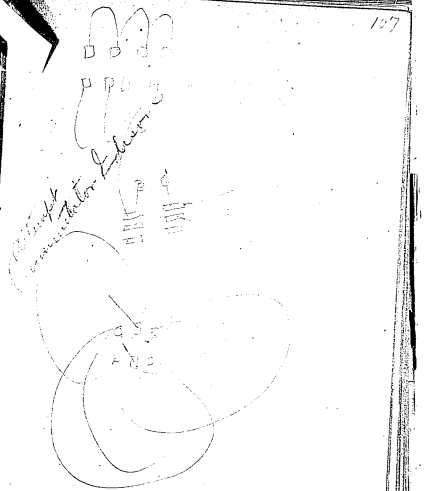
Spiral

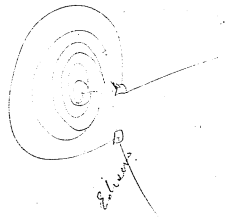
D = 13° 30' D 28°

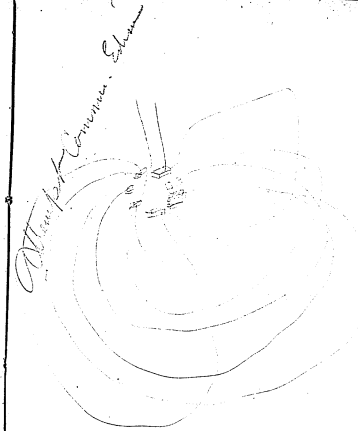
R = 3.53 ch R 5.03

9.13803	9.73947
9.38803	9.73947
.5477	.7015
19.3083	20.1709
1.3083	-.1709
	1.3083
	.8626

7.29







Bradley connection

Subdivision of gasket "

6 Electron volt cutter time

11 5·31 =

Jet temp of 4 in 72 mm

Luminescence

B

$$\frac{d}{dx}\left(\frac{f(x)}{\varphi(x)}\right) = \frac{f(x+h)-f(x)}{\varphi(x+h)-\varphi(x)}$$

Heat equation

$$\frac{f(x+h)-f(x)}{\varphi(x+h)-\varphi(x)}$$

$$\frac{f(x+h)\varphi(x)-f(x)\varphi(x+h)}{\varphi(x+h)\varphi(x)}$$

$$\frac{\left(f(x+h)-f(x)\right)\varphi(x)-\left(\varphi(x+h)-\varphi(x)\right)f(x)}{\varphi(x+h)\varphi(x)}$$

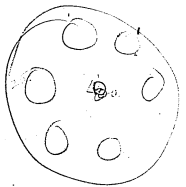
$$\frac{f'(x)\varphi(x)-\varphi'(x)f(x)}{(\varphi(x))^2}$$

$$\frac{d}{dl}\left(\frac{\varepsilon^2 nl}{(\rho+r+nl)^2}\right)$$

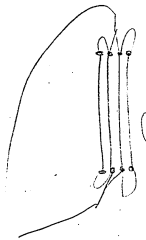
$$\frac{d}{dl}(nl)$$

$$\frac{dH'}{dnl} = \frac{\varepsilon^2(\rho+r+nl)^2 - 2\varepsilon^2 nl(\rho+r+nl)}{(\rho+r+nl)^4}$$

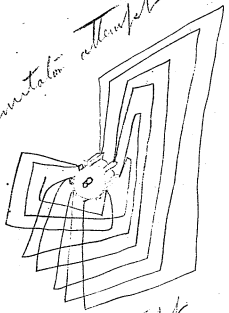
$$= 0$$



Mr. Pearce in the Phil. Journal for Jan. 1879 makes a



Communication attempt



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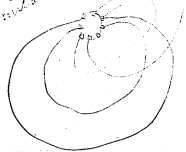
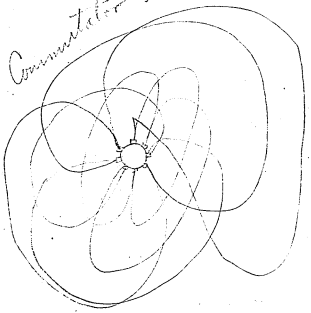
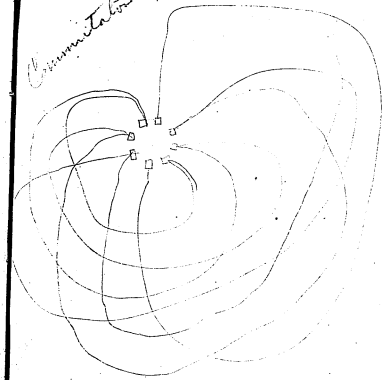
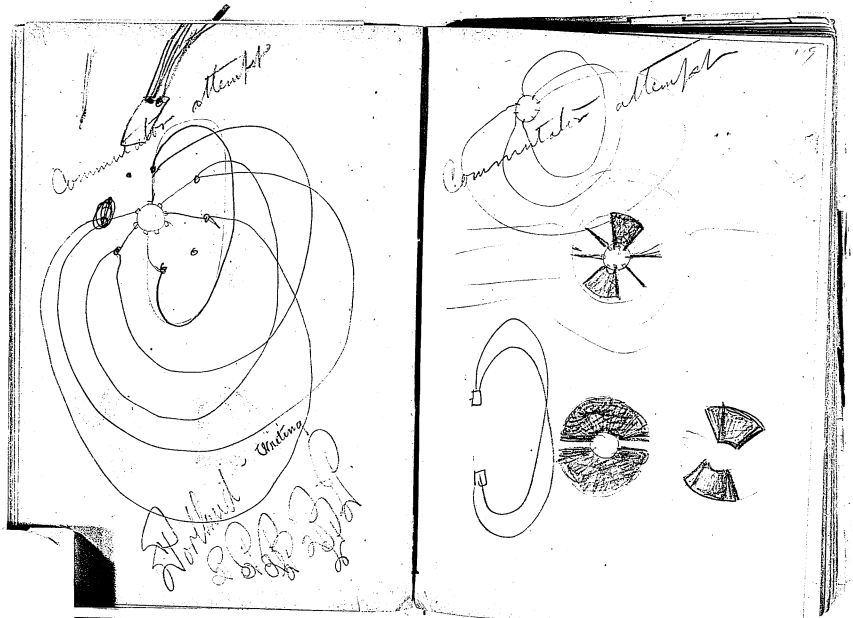


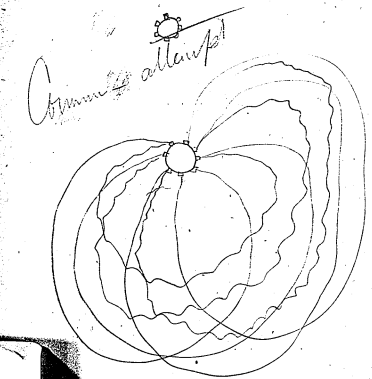
Commutateur attempt

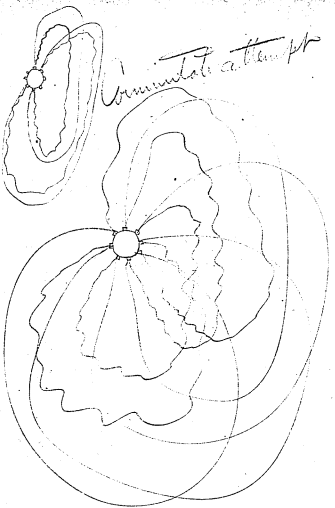


Commutateur attempt




Commutateur
Winding

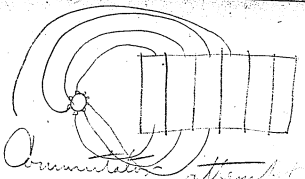

Commun attempt


Communicate attempt

Commutator attempt

$C = CR^2$ $\quad H = C^2 R$

$C = \frac{\mathcal{E}}{R}$ $\quad H = \frac{\mathcal{E}^2}{R}$



Commutator attempt

~~4000~~ 1000 / 5 = .125

2000 / 570 = 1570 / 1166

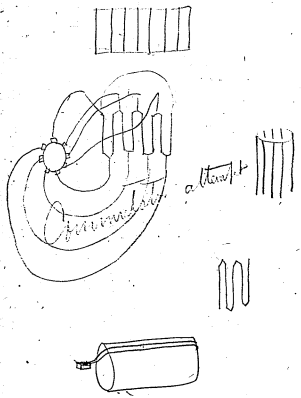
750) 600

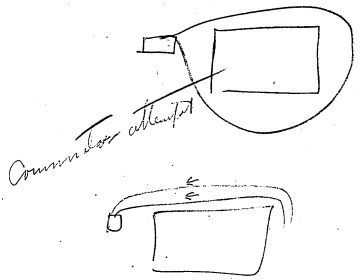
150) 100 (

392

64

12





$H' = \frac{\mathcal{E}^2 n l}{(\rho + r + nl)^2}$ in series

$H'' = \frac{\mathcal{E}^2 \frac{l}{n}}{\left(\rho + r + \frac{l}{n}\right)^2}$ multiple arc

$\rho + r = 5$ Ohms $\quad \mathcal{E} = 1$

$l = 500$ Ohms

$H'' = \frac{500}{(5.0 + 500)^2}$ $\quad n = 1$ lamp

$= \frac{500}{}$ 2.6989 / 5.4064 / 3.2925

$\log 505 = 2.7032$ / 2.7032 / 5.4064

.00196

$n = 2$ Tenths of Wire

$H'' = \frac{250}{(5 + 250)^2}$

2.40654 / 2.40654 / 4.81308

2.39794 / 4.81308 / 3

.00384

505) 500.0 (9

500 / 500 / 1000

250

505 / 505 / 2525

2525

25000 Ω

500 / (505)²

2.698970 − 2.70329 = −.00432

4.406558 − 2.70329 = 1.703268

3.29239 − .00196

250 / (255)²

2.39794 − 2.406571 = −.008631

4.81333 − 4.813202 = .000128

3.58472 − 2 = 1.58472

2 / .003840

.00192

125 / (130)²

2.096910 − 2.11394 = −.01703

4.2778 − 4.227886 = .049914

3.8791 − 4 = −.1209

4 / .00646

.00161

625 / (67.5)²

1.7958 − 1.829304 = −.033504

3.6586 − 3.6586 = 0

1.3772 − 1.8293 = −.4521

8 / .01372

.00172

n = 16

30

$$H = \frac{\mathcal{E}^2 \frac{\ell}{n}}{\left(\rho + r + \frac{\ell}{n}\right)^2} \qquad \mathcal{E} = 1$$

$\rho + r = 5$ ohms

$\ell = 500$ ohms

$n = 1$ $\quad \frac{\ell}{n} = 500$ ~~100 : 1~~ ~~$\frac{1}{500}$~~

$\rho + r + \frac{\ell}{n} = 505$ 1 lamp

.00 1965

log 505 2.703291

2.703291

5,406582

5.406582

3 . 292388

2256

132

= log .001965

$n = 2$ $\quad \frac{\ell}{n} = 250$ ~~100 : 1~~ 2 lamps

$(\quad) = 255$ 1923

log 250 2.397940 log 255 2.406540

4.813050 4.813050

3 . 584890 3 . 592590

7782 7700

0077 .001925

$n = 3$ $\quad \frac{\ell}{n} = 166.6$ ~~100 : 1~~ 3 lamps

$(\quad) = 171.6$ 1881

log ~~2.1675~~

2.221675 2.234517

15 2 15

1 3 1

2.221848 2.234685

4.469390 4.469390

3 . 752458

37

3 / .005688

.001884 .001881

$n = 4$ $\quad \frac{\ell}{n} = 125$ ~~100 : 1~~ ~~$\frac{1}{100}$~~

$(\quad) = 130$ 4 lamps

1849

2.096910 2.117271

4.234562 4.234562

3 . 862348 2.117271

4.234562

24 / 007284 2.096910

.001821 4.224118

4 / 001174 3 . 855765

.000779 3 . 869124

4 / 007794 1 1

.001849 2.117394

2.117394

4.224788

132

$n = 8$ $\frac{l}{n} = 62.5$!

100 !

( ) = 67.5 !

1.795880
3.658608
2.137272
7037
.006135

1.829304
3.658608

8 | 1.013714
.001714

$n = 10$ $\frac{l}{n} = 50.$ 100 !

( ) = 55.

1.698970
3.480726
2.218244
8010

1.740363
3.480726

10 | 1.016572
.001650

log 50 1,698970
amylog .55 8.259637
.55 8.259637
10 9.
0.1653 3.218244

133

$n = 12$ $\frac{l}{n} = 41.75$

100 !

( ) = 46.75

1.620656
3.339564
2.281092
1033
59

1.669782
3.339564

12 | 1.019102
.001591

$n = 16$

$\frac{l}{n} = 31.25$

( ) = 36.25

$n = 16$

100 !

1.494850
3.118616
2.376234
12
22
1.204120
3.172114

1.555308
3.118616

16 | 1.023781
.001486

20 lamps $\frac{pk}{n} = 25$ $\frac{500}{2p} = 25$

100 ! ! ( ) = 30

.00 13 88

1. 897940
2.582724
8.15216
179
37

1.397940
2.954242
2.443698
3576
122

1.497362
2.582724
.065 34
.003

1.477121
2.954242
.027778
.001388

21 lamps $\frac{pk}{n} = \frac{600}{21}$

100 ! !

1365

2.698970
1.322219
1.376751
3577
174

$\rho + r = 5$

23.809
5
28.809

1. 376751
2. 919054
2. 457797
77
2858
2.457597
1.322219
8.135378

1.459392
135
1.459527
2.919054

.001365

25 lamps

$\frac{l}{n} = 20.$ 100 ! !

$(\rho + r + \frac{l}{n}) = 25$

1.361030
2.795880
3.505250
1.397940
3.107310 = log .001283
210
1110

log 25 1.397940
1.377340
2.795880

30 lamps $\frac{l}{n} = \frac{600}{30} = 16.66+$

100 ! ! $(\rho + \frac{l}{n}) = 21.66+$

1.221675
157
15
2
1.221849
2.671584
2.556265
2-5
37

1,335658
120
12
2
1,335792
2.671584
3.6.035503
.001183

136

35 lamps $\frac{500}{35}$

40 Lamps $\frac{k}{n} = \frac{500}{40} = 12.5$

$100!!$ $(15 + \frac{5}{2}) = 17.5$

1.096910
2.486076
2.610734
660
74.

1243038
2.486076

.040806
.001020

137

80 lamps $\frac{500}{5-0} = 10$

$100!$ $(15 - \frac{5}{2}) = 15$
15
9.5
2.45.

$\frac{100}{2.45}$

log 1.
2.389166
2.610834
100
70

50| .040817
.000816

log 10 1.
comp log 15 8.823909
log 15 8.823909
50 8.301030
4.949848

.000816

$$H = \frac{E^2 \frac{l}{n}}{(\rho + r + \frac{\ell}{n})^2} \qquad E = 1$$

$\rho + r = 1 \qquad l = 500$ Ohms

1 Lamp $500 : 1$

$500 \qquad 2.698770$

$(501)^2$

$2.698838 \qquad 2.698970$

$5.399676 \qquad 5.399676$

$3299294 \qquad .001992$

89

5

3 lamps $\frac{\ell}{n} = 166.66+$

$500 : 1 \qquad (1+\frac{\ell}{n}) = 167.66+$

$2.221848 \qquad 2.222746$

$4.445780 \qquad 156$

$3.776068 \qquad 16$

$47 \qquad 2$

$21 \qquad 2.222898$

4.445780

$\log 1.6059713$

$.001990$

10 lamps $\frac{\ell}{n} = 50$

$500 : 1 \qquad () \quad 51$

$1.6698970 \qquad 1.7075570$

$3.4151140 \qquad 3.4151140$

$2.2838830 \qquad 01922$

$3753 \qquad .001922$

77

16 lamps $\frac{\ell}{n} = 31.25$ $16\overline{)500}$ @ 125

$+1 \quad 32.25$ 48 20 16 4

$500 : 1$

$1.4994850 \qquad 1.5085830$

$3.0170600 \qquad 3.0170600$

$2.4777790 \qquad 3004$

700

1.2041200

$3.2736700 \qquad .001877$

464

20 lamps 25

26

$\log 26 = 1.3979400$

$\log 26 \quad 1.$

146

~~25 lamps~~ 20
21

1.301030
2.602392
2.694638
1.397940
3.296698

1.303196
2.806392
1880

25 lamps

log 20 1.301030
log 21 1.322219
2.444638
2.656592
1.397940
3.258652
37

500 : 1
1814

40 lamps 12,5 — 13.5

log 12,5 = 1.096910
log 13,5 = 1.130334
2.266668
2.192242
1.602060
3.234182
1715

80 lamps 500/400 = 1
log 6.25 0.795880
comp 7.25 9.139662
72.5 9.139662
80. 1.903090
1486 3.172114

50 lamps 141
log 10 = 1.
log 11 = 1.041393
2.958607
1.041393
2.082786
2.917214
1.698970
3.218244
1652

60 lamps 15594
3.202729
60 lamps, 15594

80 lamps 8.333
log 6.25 0.795880
7.25 0.860338
1.656218
2.875264
1486 1.903090
1.972114

500 : 1
1486

1.
1,556303
1,443697
2
3.443394

,698970
1,556303
1,142667
2
3.142636

100 lamps 500 : 1

142

90 lamps 500:1

9 | 50

5,555

Log 5,5553 0,744293

6,55554 0,8

.7446 84

34

4

.1744727

.8166610

.16332220

1,111507

1.954243

3 .157264

.00 1436

8 | 50

6,25

1,25

0,795880

0, 860338

1,720676

1 07526 04

1,90 30 90

3 ,17211 4

.00 1486

100 lamp 500:1

.00 1386

1000 143

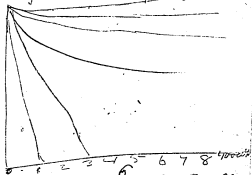
$\frac{l}{n}$

$l = (\rho + r + \frac{l}{n})^2 \rho + r$

$l = 2000$

$l = 1000\ (\rho + r)$

$l = 500\ (\rho + r)$.



$\frac{l}{n}$

$(\rho + r + \frac{l}{n})^2$

$\frac{l}{n}$

$(\rho + r + \frac{l}{n})$

$\frac{l}{n}$

$(\rho + r + \frac{l}{n})$

$\frac{l}{n}$

$(\rho + r + \frac{l}{n})$

250

~~4000~~ to one

Four thousand to one.

i.e. 4000 Ohms in lamp & bt.

1000 Ohms in lamp $\frac{1}{4}$ in machine

1 lamp $\frac{e}{n} = 4000$

$= 4001$

25 lamps $\frac{e}{n} = 160$

161

$\frac{e}{n}$ 4000

500 500. 1 Lamp 4000 : 1

500.	2698970	2,698970
500.125	1.096970	2,699077
	1.793820	5.398154
		3.300876

.00 1999

50 lamps 4000

10 ohms

50 500

10

10.	1.
10.125	1.005.999
	2,011,998
	1.988002
.1990	1.698970
	3.289032

~~1000~~ 100 Lamps ~~4000~~ 4000 : 1

100 lamps $\frac{e}{n} = 5$ lamp = 500

$.125 + \frac{e}{n} = 5.125 + r = .125$

$= 5,125$

log 5	0.698970
5,125 =	0,709694
	1.419388
	1 279582
	2
.00 1903	3.279582

Lamp 1p Ohms 1:1
Lamp 500 Ohms
$\rho + r = 500$ 1 lamp

$\frac{500}{500+500} = \frac{1}{1001} = .002000$

$\frac{500}{1000} \frac{5}{1000} .005$

2 lamps

1.5	1.698970
1.5	0.176091
log 1.5	1.698970
comp log 1.5	9.823909
1.5	9.823909
2.	9.698970
	1.046788
	.301030
	1.045758

1105
2 | 11620
500 | 1.0581
500 | .00116
250

250 | 1.0581
500 | 11626
.000232

2 lamps 1:1

250	2.397940
comp. 750	7.124939
750	7.124939
up 2	9.698970
	4.346788

.002324

3 lamps 1:1

166.66	2.222675
666.66	2.823874
	5.646948
.000345	4.574727
.000125	

4 lamps 1:1

125.	2.096910
625.	2.795880
	8.001030
	5.591760
	4.505150

.000320
.000080

500

2 lamps

$\frac{800}{2} = 250$

Log 250
comp log 750

$\frac{250}{(500+750)^2} = \frac{250}{(1250)^2} = \frac{1}{(5\times 250)^2} = \frac{1}{(5\times 5)^2} = \frac{1}{625} = .0016$

2.	2.397940
7.	7.124939
7.	7.124939
4.	9.698970
	4.346788

3 lamps
log 166.6

4000 : 1

500 ohms in lamp

.125 ohm = g + r

---

200 lamps

$\frac{l}{n} = 2.5$ — 0.397940

.147 $\frac{l}{n} = 2.625$ — 0.419129 / .138258 / 1.559682

200 1.00.3629

.001814

~~600~~ lamps 4000 : 1

$\frac{l}{n} = 1.25$

$.125 + \frac{g}{n} = $ ~~1.25~~ 1.375

---

log 1.25 — 0.096910 / .138303 / .276606 / $\bar{1}$.820304 / 2.602060 / $\bar{3}$.218244

.00165 3

---

600 lamps 4000 : 1

$\frac{l}{n} = \frac{500}{600} = .833$

.833 .125+ .958

$\bar{1}$.920665 / $\bar{1}$. / $\bar{1}$.920817 / $\bar{1}$.981516 / ~~3934~~ / $\bar{2}$.963032 / .957785 / .778151 / .179634

.00152

1000 lamps 4000 : 1

$\frac{500}{1000} = .5$

.125 + = .625

$\bar{1}$.698970 / 1.795880 / $\bar{1}$.591760 / $\bar{1}$.107210

.1288

$\bar{1}$

150

1500 Lamps 4000 : 1

500/1500 = .3333+

.1254.3333 = .145837

.3333 — T. 5.22875
T. 661178
T. 322356
.200519
3. 176091
3 .024428

.000 105-2

2000 Lamps 4000 : 1

500/2000 = .25

.1254.25 = .375

log .25 — T. 899940
log amp .375 — 10. 425969 − 10
" " .375 — 10. 425969 − 10
log amp 2000 — 6. 698970 − 10
26. 948848
30.
4. 948848

.000 888

2500 Lamps . 4000 : 1

500/2000 = 1/5 = .2

log . 2 — T. 301030
log amp . 325 — 10. 488117 − 10
" " .325 — 10. 488117 − 10
" " 2500 — 6. 602060 − 10
26. 879324
30.
4. 879324

.000 757

3000 Lamps 4000 : 1

500/3000 = .1666
125
.2916

log .1666+ — T. 221675
log amp .2916+ — 10. 537212 − 10
" " .2916+ — 10. 537212 − 10
" " 3000. — 6.
36. 614498
30.
4. 814911

653

4000 lamps · 4000 : 1

500/4000 = .125

log .125 $\bar{1}$.096910
Comply .250 10.602060 10
.250 10.602060
6.397940
4.698970

4000 : 1

5000 lamps 4000 : 1

$\frac{d}{h}$ = .1 $\bar{1}$.
$\frac{d}{h}$ = .125 .225 10.647817
10.647817
6.301030
4.596664

.000 395

6000 lamps

$\frac{d}{h}$ 500/60.00 .0833
.0833+ $\bar{2}$.920645
.2083 10.681311
10.681311
6000 6.221849
.000320 4.503116

8000 4000 : 10,000

$\frac{d}{h} = \frac{5}{200} = .0625$

.0625
.0625 $\bar{2}$.795880
.1875 10.726999
.1875 10.726999
8.000 6.096910
.000222. 4.346788

.05 $\bar{2}$.698970
.175 10.756961
10 10.756961
4.212892
.000163

3000 : 1

d = 500 $\frac{p+r}{h} = \frac{500}{3000} = .1666$

1 lamp $p+r = \frac{500}{3000} = .1666$

log .1666 500 2.698979
Comp 500. 1666 .699107
.300893
.300893
3.300765

1996

50 lamps $\frac{d}{h} = 10$

log 10 1.
Comp 10.1666 .7783325
10.1666 .7783325
50. 8.301030
1.857680

1935

6894
254
25
5
1178
8.992822
8.992822
8.301030
3286674

250 lamps $\frac{500}{250} = 2$

2
2.1666
2.6666
250
5076

0.301030
9.666667
9.666667
7.602080
3.631904
3.834674

5458
111
12
1
5792
301030 5592
66 42085 65-8
66 42085 12 1
12
60 2660 1
5792
3231506
1704

200 lamps 3000 : 1

500/200 = 2.5 .1666+ 2.6666+

log 0.397940 .64167 .142 14 1 6624

9.73666 24 23 16 9.73666 24 7.698970 3.570158 2

200 lamps 3000 : 1

$\frac{l}{n} = \frac{500}{200} = 2.5$

$n + \frac{l}{n} = .1666 + 2.5 = 2.6666$

log 2.5 0.397940 5880 95 9

comp log 2.666 9.574036 5964

2 9.574036

200 7.30 1030

84706

7.698970

3 .244982

∴ 1757

500 lamps 3000 : 1 15½

$\frac{l}{n} = \frac{500}{3000} = .1$

log 1 = 0. B699 228 23 2 6952

log comp 1.166+ = 9.933048

= 9.933048

Comp. log. 500 = 7.301030

3.167126

.001469

1000 lamps $\frac{500}{1000} = \frac{1}{2}$ 500 .5 2000 .166

$\frac{l}{n} = .5$ .2666+

log .5 = 1. 4569 37 4606

comp log .7666+ = 10. 1.678970 5971 10. 1.135777 5391 10. 1.135777 7.

comp log 1000 = 7.

.000552 = 4.149800 4. 930512 92975 2

.001412 3.

1500 lamps

log .3833+ 1. 2.2248 6

comp log .4999+ 10.301030

.4999+ 10.301030

1500. 6.823709

4.948955

.000888

1000 lamps

.5 1. 678970

.1666+ 10. 176093

.1666+ 10. 176093

1000. 7.

3 052166

.1127

3865 42 3907

Conductors

25 to 1

1 Lamp $\frac{500}{25} = 20$ $C = 500$

$g + r = 20$ Ohms

Log 500	2.698970
Comp log 520	7.283997
520	7.283997
	3.266964

.001849

2 Lamps

250		500
log 250.	2.397940	2.397940
comp. log 270.	7.560667	7.568636
270.	7.560667	7.568636
2.	9.698980	9.698970
	27.218244	3.234182
	3.	

.001714

3 Lamps

166.66	166.66	0912
20	8 5 5	139
186.6	2.221854	14
	7.728935	1
	1.738934	.1066
	9.622879	
	.322202	

3

3 Lamps 25.61

$\frac{500}{3} = 166.6+$

log 166.6+	2.221854	1414
comply 186.6	7.728935	161
186.6	7.728935	16
3.	9.522879	2
	3 2.202603	1593
1595		1675
		161
		16
		2
		1854
		2709 12
		138
		14
		2710 65

4 Lamps 25.11

$\frac{500}{4} = 125.$

log 125	2.096910
comply 145	7.838632
	7.838632
4	9.397940
	3.171114
	2

.001490

1486

20 : 1

5 camps $\frac{500}{5} = 100$

$8 + r = 20$

log 100: 2.
comp log 120. 7.920819
120. 7.920819
5. 9.301030
3.142668

.1389

25 : 1

10 camps

log $\frac{500}{10} = 50$ 1.698970
70 8.154902
70 8.154902
10 9.
3.607834
.0010274 3.008774

20 : 1

16 camps $\frac{500}{16} = 31.25$

log 31.25 1.494850
comp log 51.25 8.290306
51.25 8.290306
16. 8.795880
3.071342
.0001178 4.871342
.0000743

16)500 (31.25
48
20
16
40
32
80

25 camps

log $\frac{500}{25} = 20$ 7.301030
40 8.698970
40 8.397940
40 8.397940
25 8.602060
3.096910
.0001258 4.698970
.0000500

25 : 1

6 lamps.

log 500/6 = 83.33+ → 1.920818
comp log 103.3+ → 7.985761
103.3+ → 7.985761
6. → 9.221848
...1301 → $\bar{3}$.114188

7 lamps.

log 500/7 = 71.4285+ → 1.853874
comp log 91.4285+ → 8.038918
91.4285+ → 8.038918
7. → 9.154902
1221 → $\bar{3}$.086612

8 lamps.

log 500/8 = 62.5 → 1.795880
comp log 82.5 → 8.083283
82.5 → 8.083283
8. → 9.096710
...1146. → $\bar{3}$.059356

25 : 1

9 lamps.

log 500/9 = 55.55+ → 1.744731
comp log 75.55+ → 8.121733
75.55 → 8.121733
9. → 9.045757
1095 → $\bar{3}$.033954

11 lamps.

log 500/11 = 45.45-45+ → 1.657582
65.45-45+ → 8.184057
65.45-45 → 8.184057
11. → 8.758607
...964 → 4.784303

12 lamps.

log 500/12 = 41.666+ → 1.620425
61.666 → 8.209055
67.666 → 8.209055
12. → 8.920819
895 → 4.955204

162

25:1

13 lamps

500 / 13 = 38.4615

log 38.4615 1.585027

comp log 38.4615 8.233130

38.4615 8.233130

13. 8.886057

.000 865 26.937344

4.

log 500 = 2.698970

comp log 13 = 8.886057

1.585027

38.4616

14 lamps

log 500 = 2.698970

comp log 14 = 8.853872

1.552842

log x = 35.714 = 4.254032

comp log (20+x) 55.714 = 8.254032

(20+x) = 8.853872

14 = 4.914778

.000 821

163

15 lamps 25:1

500/15 = 33.33+ = 1.522879

Comp log 33.33+ = 8.279450

33.33+ 8.279450

15. 8.823909

.000 804 4.905688

17 lamps

log 500 = 2.698970

Comp. log 17 = 8.769551

1.468526

log 29.412 = 8.306167

comp log 49.412 = 8.306167

11 = 4.849411

.699

5 : 1

1 lamp $p+r=100$

log 500	2.698970
comp log 600	7.221849
600	7.221849
.001388	3.142668

2 lamps

log	250.	2.397940
comp log	350.	7.455932
	350.	7.455932
	2.	9.698970
.001020		3.008674
.000226		

4 lamps

log	125.	2.096910
comp log	225.	7.646853
	225.	7.646853
	4.	9.397940
.000617		4.790290

5 lamps

.001500

.000500

5 : 1

8 lamps

log	125	2.096910
	225	1.647819
	225	7.647814
	8	9.096910
.000308		4.489448

10 : 1

1 lamp p + r = 50

log	500	2.698970
comp log	550	7.259637
	550	7.259637
	.000 7653	3.218244

5 lamps

log 100 — 2 — .000 500

comp log 200

5 lamps — 5 lamps

log	150	7.823909
comp log	150	7.823909
comp log	5	7.301020
	.000 889	4.948848

10 lamps

50.	7.798970
100.	8.
100.	8.
10	9.
.000 500	4.798970

16 lamps 10 : 1

log 31.25	=	1.494850
comp log 81.25	=	8.090177
81.25	=	8.090177
16.	=	8.795880
.000 303		4.481084

25 lamps

log 200	
70	1.301030
comp log 80	8.221849
60	8.221849
25	8.602060
	4.346988
222	

168

30 ; 1 $\rho + r = 10$

1 Lamp

log	500	2.698970
comp log	510	7.292430
	510	7.292430
		3.283830

.001922

5 Lamps

log	100.	2.
comp log	110.	7.958607
	110.	7.958607
	5.	9.301030
	16.53	3.218244

.001653

10 Lamps

log	50	1.698970
comp log	60	8.221849
	60	8.221849
	10.	9.
		3.142668

.001389

20 Lamps

log	25	1.397940
comp log	35	8.455932
	35	8.455932
	20	8.698970
		3.008774

.001020

169

50 : 1 $\rho + r = 10$ $l = 500$

50 Lamps

log	10	1.
comp log	20	8.698970
	20	8.698970
	50	8.301030
		1.698970

.000500

8 Lamps

$\frac{500}{8} = \frac{625}{1000}$

log	62.50	1.795880
comp log	78.25	8.139662
	78.25	8.139662
	8.	9.030900
		3.172144

.001485

16 Lamps

log	32.25	1.508530
comp log	42.25	8.374173
	42.25	8.374173
	16.	9.079588
		3.055756

.001135

170 250:1 $f+r=\#2$ $\ell=500$

1 lamp

log	500	2.698970
comp log	502	7.299296
	502	7.299296
		3.297562

.001984

10 lamps

log	50	1.698970
comp log	52	8.283997
	52	8.283997
	10	9.
		3.266964

.00 ~~1846~~
18.49

20 lamps

log	25	1.397940
comp log	27	8.568636
	27	8.568636
	20	8.698970
		3.234182

.001714

50 lamps.

log	10	1
comp log	12	8.920819
	12	8.920819
	50	8.301030
		3.142668

.001389

80 lamps 250:1 171

$\frac{500}{80}$ =	6.25	0.795880
comp log	8.25	9.083546
	8.25	9.083546
	80	8.046910
		3.059882

.1147

100 lamps

log	5	0.698970
comp log	7	9.154902
	7	9.154902
	100	8.
		3.008774

.001020

125 lamps

log	4	0.602060
comp log	6	9.221849
	6	9.221849
	125	7.903090
		4.948848

.000888

25 lamps
log 2

n^2 1000 : 1 $p+r = .5$

1 lamp

log	500	2.6989700
comp log	500.5	7.3005996
	500.5	7.3005996
	.001998	$\bar{3}$.3001622

50 lamps

log	10	1
comp log	10.5	8.9778811
	10.5	8.9778811
	50.	8.3010300
	1814	$\bar{3}$.2586552
	.001772	

100 lamps

log	5	0.6989700
comp log	5.5	9.2596377
	5.5	9.2596377
	100.	8.2596377
		$\bar{3}$.2182244
	.001653	

200 lamps

log	2.5	0.3979400
comp log	3.	9.5228794
	3	9.5228794
	200	7.6989700
	.001389	27.1426588
		$\bar{3}$.

250 lamps 1000 : 1

log 2	0.301030
comp log 2.5	9.602060
2.5	9.602060
250.	7.602060
1280	$\bar{3}$.107210

400 lamps

log 1.25	0.096910
comp log 1.75	9.756762
1.75	9.756762
400.	7.397940
.001020	$\bar{3}$.008374

500 lamps

log 1.	0.
comp log 1.5	9.823909
1.5	9.823909
500	7.301030
.000888	$\bar{4}$.948848

$\frac{1}{10}$ ohm
10 ft. long

$R = \frac{\text{Length}}{\text{Cross Section}} \text{ Constant}$

Cross Section $= \frac{\text{Length}}{R} \text{ Constant}$

Cross Section $= D^2\pi$ in .001 in. makes

Length in ft

R Constant = the resistance of 1 ft of wire .001 in in diameter in Ohms

$$\text{Constant} = \frac{\text{Length}}{C \times R} \qquad \frac{1760 \cdot 3}{5280}$$

$$= \frac{5280}{\pi \times .01^2 \times \pi} \times 530.35$$

that is 5280 ft of Cu wire .01 in diam has a resistance of 530.35

log 5280. = 3.722634
comp log 31.41592 = 18.502850
" " 530.35 = 7.275436
3.500920
∴ 3164.9 D in inches

.038 in. wire

$\text{Length} = \frac{R \cdot \text{Cross Section}}{\text{Constant}}$

$R = \frac{\text{Length}}{5280} \times C \times \pi D^2$

3.722634
3.500920
comp π 9.502850
.038 11.420216
.038 11.420216
39.566836
0

.001

100 ft
200 ft
300 ft
400 ft
500 ft
600 ft
700 ft
800 ft
900 ft
1000 ft
1200 ft
1400 ft

$R = \frac{l}{\pi D^2} C$

$\frac{\pi D^2}{4} = \frac{l}{R} C$

$\frac{D}{2} = \sqrt{\frac{l}{R\pi}} C$

$D = \sqrt{\quad} \quad D = .001$ in

C = resistance of 1 ft. of the wire .001 in in diameter

$C = 10.3365$

πR^2 πD $2\pi R$ $\frac{1}{2}\pi R^2$ $\frac{\pi D^2}{4}$

$D = \sqrt{R}\sqrt{\frac{C}{R\pi}} \cdot \frac{100}{92}$

log 10.3365 = 1.014380
comp log .001 = 3. −10
comp log 3.141592 = 9.502850 −10
log 100 = 2
comp log 92 = 8.036212 −10
2 | 3.553442
1.776721

$D = 357.6 \sqrt{\quad} = 18.91$

$R_s : R_p :: \frac{1}{92} : \frac{1}{100}$

100 : 92

$R_s = \frac{92}{100} R_p \quad \frac{100}{92} R_p$

100 ft 0.189.1 in
1000 1.891 in

1.1706 ft 110

0.068186
250
2 | 0.068426
0.034218
1.276721
1.309139

1.276721
.036212
1.740509

20.46 55.02
2
110.0 4

$$R = \frac{L}{\frac{\pi D^2}{4}} C = \frac{4LC}{\pi D^2}$$

$$\pi D^2 = \frac{4LC}{R}$$

$$D = \sqrt{R} \sqrt{\frac{4C}{\pi R}}$$

C = Constant, the resistance of one foot Cu .001 in in diameter.
= 10.3665 Ohms for Lake Superior Cu multiplied by 1.032
.001 Ohm = R by L = variable.

log.	4,	= 0.602060
log.	10.3365	= 1.01 4387
log	100.	= 2.
comp log	π	= 9.502850 −
comp log	.001	= 13. −
" "	92.0	= 8.036212 −
		2 | 4.155504
	1195	2.07775
		.036212
6.6465 | 2 | 0.781513		2.041540
	0.390756	
	2.041540	
270	2.432296	

1.706	6.068436	
	2.041540	
	2.109976	
128.	.034218	
119.6	2.075758	

1.3931	2 | 0.143987	
	0.071993	
	2.041540	
129.9	2.113537	

.9675	2 | 1.985657	
	1.992825	
	2.041540	
108.0	2.034365	

.00155	2 | 3.190332	.0967
	2.595166	16
	2.041540	5802
4.332	.636706	967
		1.547

$$R = \frac{4Lc}{\pi D^2}$$

$$L = \frac{QRa}{4L} \cdot \frac{\pi D^2}{4L} = \frac{\pi D^2 \cdot R}{4c}$$

$$D^2 = \frac{4Lc}{\pi R}$$

$$D = \sqrt{\frac{L}{L}} \sqrt{\frac{4c}{\pi R}} =$$

$C = 10.3365$

4

~~41.5400~~

10.3365 ohms in 1 foot of .001 wire.

$$R = \frac{L}{D^2} c$$

$$D^2 = \frac{L}{R} c$$

$$D = \sqrt{\frac{L}{R}} \sqrt{c}$$

10.9

10.3365 ohms

1.014382

8.985618

.096744

2

$$D^2 = \frac{L}{R} c \qquad R = .001$$

$$D = \sqrt{\frac{L}{R}} c \qquad C = 10.3365 \qquad L = .00155$$

Log 10.3365 1.014382

comp of .001 13.

4.014382 — 10

Log .00155 3.190332

2 1.204714

4.00 .602357

$(10.3365 \times 1.55)^{\frac{1}{2}} = 4$

$\left(10.3365 \times \frac{.00155}{.001}\right)^{\frac{1}{2}} = 4$

Log $\sqrt{\frac{L}{R}}$ = 2.007191

Log 6.0465 .781505

2.788696

.390754

.250 2.397945

log $\frac{C}{R}$ $\frac{100}{92}$ $R = .001$

log $\frac{C}{R}$ = 4.014382

log 100 2.

comp log 92 ~~1.963788~~ = 8.036211

4.050593

100 ft

2 | 6.05.05.93

3.025296

1.060

---

200 ft

4.05.05.98

6

2.05.05.93

4.301030

2 | .3516.23

.1758.61

1.509

---

300 ft

2.05.05.93

2.477121

2 | .527714

.263857

1.836

400

2.05.05.93

2.602060

2 | 0.652653

.326327

2.120

500

2.05.05.93

2.698270

= (.749563

.374781

2.370

600

2.05.05.93

2.778151

(.828744

.414372

2.596

700

2.05.05

2.845098

.895691

.447845

$R = \frac{L}{D^2} C$

$\frac{C}{R}$ $\quad$ $\frac{C}{R}$ $\quad$ $R = \frac{L}{D^2} C$

$C_{.001}$ = Ohms in one ft. .001 wire

$C_{\frac{1}{2}}$ = 1000 $C_{.001}$

$D = \sqrt{L} \cdot \sqrt{C_{.001} \div 1000} \div$ in inches
$\sqrt{R}$ in inches
.001

(Ref) $\frac{C_1}{1000} = C_{.001}$

Lake Superior

log C = 1.050593 $\div$ 1000
in .001 in.

log. C = $\overline{3}.050593$
in inches

R = equals resistance given
L = length variable
D = Diameter to be found
D.

100 feet $\log 100 = 2.$

Ohms		
	3.652653	.6704
.00025	1.826326	
.0005	3.301030	43.71
	1.650515	
.001	3.050593	33.51
	1.525196	
.002	2.749563	23.70
	1.374781	
.004	2.448533	16.78
	1.224266	
.01	2.050593	10.6
	1.025296	
.02	1.749563	07.49
	.874781	
.04	1.448533	05.3
	.724261	
.1	1.050593	
	.525296	03.35
.2	.749563	
1.	.374781	02.37
	.025296	01.06
2	1.749563	
	1.874781	.0074
5.	1.351623	
	1.675811	.0047

1 : 1 $\quad p + r = 500$

100 Examples

log 5. 0.698970
comp log 505. 7.296709
7.296709
23.292488

$\overline{7}.292488$

.0000000019961

.01961

$\frac{500}{750} \frac{2}{3}$

750 : 1 $\quad p + r = .6666$

log 500 = 2.698970 9491
500.6666 7.300445 57
6666 7.300445 6
9554
.079460
$\overline{3}.299860$

75 : 1 2.698970 4665
57
comp log 506.666 7.295274 6
506666 7.295274 4726
$\overline{3}.289518$

1946

$\frac{\frac{l}{n}}{\left(r + \frac{l}{n}\right)^2} = \frac{l}{n r^2 + 2\frac{nl}{2} + \frac{l}{n^2}}$

$\frac{nl}{(nr + l)^2} \quad + \frac{1}{nl} = 1$

$\frac{1}{(r+1)^2}$

$\frac{1}{5} \quad \frac{1}{(r+1)^2} = \frac{4}{\left(r + \frac{1}{2}\right)^2}$

$\frac{\frac{l}{n}}{\left(r + \frac{l}{n}\right)^2} =$ [illegible]

$\frac{l}{n} = 10 \quad \frac{500}{50}$

$\frac{l}{n} = 10 \quad \frac{100}{100}$

250 : 1

$r = 2$ 125.

$\frac{10}{(2+10)^2}$

20

$\frac{\frac{l}{n}}{\left(r + \frac{l}{n}\right)^2} \quad \frac{x}{(y+x)^2}$

$\frac{\frac{l}{n}}{\left(r + \frac{l}{n}\right)^2} = \frac{l}{\left(\frac{nr + l}{n}\right)^2} \quad \frac{1}{\left(y + \frac{1}{x}\right)^2} = 3$

$\frac{nx}{(nr + l)^2}$

$\frac{1}{n}$ $\quad n = 10$

$\frac{1}{\left(r+\frac{1}{2n}\right)^2}$ $\quad \frac{1}{10}$

$\frac{2n}{(rn+1)^2} = \frac{2n}{(r'n+1)^2}$ $\quad r = \frac{1}{2}r'$

$2n \quad 2n = \frac{1}{2}n'$

$r = 2r'$

$\frac{\frac{1}{2}n'}{(r'n'+1)^2} = \frac{\frac{1}{n}}{\left(r+\frac{1}{2n}\right)^2}$ $\quad \frac{\frac{1}{n}}{\left(r+\frac{1}{2n}\right)^2} = \frac{1}{(rn^2+n)^2}$ $\quad \frac{\frac{1}{n}}{(2+\frac{1}{n})^2}$

$rn^2+n = B$

$n(rn+1) = B$

$n = \frac{1}{2}n'$

$\frac{1}{2}n'(\frac{1}{2}rn'+1) = B$

$n'(rn'+1) = B$

$\frac{1}{2}rn^2 = 2r'n'^2$

$r = 4r'$

$rn^2+n = B$

$\frac{1}{4}rn'^2+\frac{1}{2}n' = r'n'^2+n'$

$rn'^2+2 = 4r'n'+4$

$rn'^2 = 4r'n' = 2A$

$r = 4r' = \frac{2}{n}$

4000 : 1 $\quad n = 200$

2000 : 1 $\quad n = 100$

$r = \frac{500}{4000} = .125$ $\quad \frac{500}{2000} = .250$

$\frac{2.5}{(.125+2.5)^2} = \frac{5}{(.250+5)^2} = \frac{2.5}{\left(\frac{.250+5}{2}\right)^2}$

$\frac{\frac{2}{n}}{\left(r+\frac{2}{n}\right)^2} = \frac{2\left(\frac{2}{n}\right)}{\left(2r+\frac{2}{n}\right)^2}$ ②

$= \frac{\frac{2}{n}}{\left(\frac{2r}{2}+\frac{2}{2n}\right)^2}$

$\frac{\frac{2}{n}}{\left(r+\frac{2}{n}\right)^2}$

190

$$\frac{\frac{\ell}{n}}{\left(r+\frac{\ell}{n}\right)^2} \quad -$$

$$\frac{\frac{1}{n}}{\left(r+\frac{1}{n}\right)^2} \qquad \frac{1}{\left(\sqrt{n}\left(r+\frac{1}{n}\right)\right)^2}$$

$$\frac{1}{\left(r\sqrt{n}+\frac{1}{\sqrt{n}}\right)^2}$$

$n = \frac{1}{2}n'$ $\quad r = \frac{1}{2}r'$ $\qquad \frac{\frac{n'}{2}}{\left(\frac{n'}{2}+\frac{n'}{n'}\right)^2}$

$n = \frac{1}{2}n'$ ‖
$r = \frac{1}{2}r'$ ‖

$n = \frac{1}{2}n'$ $\quad r = \frac{1}{2}r'$ $\qquad \sqrt{n} = \sqrt{2}\,n'$ $\quad r = \frac{1}{2}r'$

$$\frac{1}{2n'} \qquad \sqrt{n}\,r = \sqrt{2n'}$$

$$\frac{1}{\left(\frac{1}{2}r'+2n'\right)^2} \qquad nr = n'r'$$

$$\frac{1}{\left(\sqrt{2n'}\,r'+\frac{1}{\sqrt{2n'}}\right)^2} =$$

191

$$\frac{\frac{\ell}{n}}{\left(r+\frac{\ell}{n}\right)^2} \qquad r = \frac{1}{k}$$

$$\frac{\frac{\ell}{n'}}{\left(r+\frac{\ell}{n'}\right)^2} \qquad = \frac{\frac{\ell}{n'}}{\left(r+\frac{\ell}{n'}\right)^2}$$

$$\frac{\ell}{(nr+\ell)^2} = A \qquad n = 2n' \quad r = \frac{1}{2}r'$$

$$\frac{\ell}{(n'r'+\ell)^2} = A$$

500

$$\frac{\frac{\ell}{n^2}}{\left(\frac{\ell}{r}+\frac{\ell}{n}\right)^2} = \frac{\ell}{\left(\frac{\ell n}{r}+\ell\right)^2}$$

$$\frac{1}{\left(\frac{n}{r}+1\right)^2}$$

$\boxed{\frac{1}{75}}$

750

35 20
50 15
25 10
10 5
5 3
375 2

192

$\frac{1}{75}$

$\frac{1}{75}$ $\frac{1}{75}$

$\frac{\ell}{\left(\frac{n}{r}+\ell\right)^2}$ $\frac{\ell}{\left(\frac{\ell n}{r}+\ell\right)^2}$

$\frac{1}{\ell\left(\frac{n}{r}+1\right)}$ $75\overline{)7500}$ 100

$\ell\left(\frac{1}{\frac{1}{75}+1}\right) = \frac{1}{\frac{76}{75\,500}}$

$= \frac{75}{76 \times 500}$

$\frac{75}{76 \times 500}$ $\frac{750}{75}$

$\frac{1}{\ell\left(\frac{n}{r}+1\right)}$ $r = 750$

$n = 10$
$n = 15$
$n = 20$
$n = 25$

193

$n = 1$ $\frac{500}{750 \times 500}$

$\frac{1}{500\left(\frac{1}{750}+1\right)} = \frac{750}{500 \times 751}$

$n = 2$ $\frac{325}{500 \times 326}$

$n = 10$ $\frac{1}{500\left(\frac{10}{750}+1\right)} = \frac{75}{500 \times 76}$

comp log 500 = 7.301030 $\frac{1}{75}$
log 75 1.875061
comp log 76 7.119186
$\overline{3}.295277$ .1973

$\frac{\frac{\ell}{n}}{\left(\frac{\ell}{r}+\frac{\ell}{n}\right)^2} = \frac{\ell}{\ell^2\left(\frac{n}{r}+1\right)^2}$

$\ell = 500$
$n = 10$
$r = 750$ $\frac{1}{75}$

$\frac{1}{\ell\left(\frac{n}{r}+1\right)^2}$

$\frac{1}{500\left(\frac{10}{750}+1\right)^2} = \frac{.002 \times 75^2}{76^2}$

$\overline{3}.301030$
1.875061
1.875061
8.119186
8.119186
$\overline{3}.289524$

1948

194

$\frac{1}{30}$ $\frac{.002\ 4830^2}{31^2}$

$\bar{3}.301030$
1.477121
1.477121
8.508638
8.508638

.00 1873 $\bar{3}.272548$

$\frac{1}{150}$

$\bar{3}.301030$
2.176091
2.176091
7.821023
7.821023

1973 $\bar{3}.295258$

$\frac{3}{500}$ Eng .002 $\bar{3}.301030$

Eng 000. 2.698970
2.698970

Complex 503. 7.298432
7.298432

1976 $\bar{3}.295834$

$\frac{1}{80}$ $\bar{3}.301030$
1.903090
1.903090
8.091515
8.091515

.00 1951 $\bar{3}.290246$

195

$\frac{1}{200}$ $\bar{3}.301030$ $\frac{1}{500}$ $\frac{200}{201^2}$
2.301030
2.301030
7.672804
7.672804

$\bar{3}.298698$ .1980

$\frac{1}{230}$ $\bar{3}.301030$
2.397940
2.397940
7.600326
7.600326

1984 $\bar{3}.297562$

$\frac{1}{\ell\left(\frac{n}{r}+1\right)^2}$ $n =$ $r = 1$

$\frac{1}{\ell X (n+1)^2}$ $\frac{.002}{25.}$ $(n=4)$

~~2000~~ 36

2000

3.301030 5535

8.443696 18795

1.744726

3.301030 6

8.309804 40.83

1.610834

7 3.301030

8.193820 31.25

1.494850

8, 19 9.045757

9.045757 24.69

1.392544

9, 10 3. 20.00

9.

9.

1.301030

10 compling 11 8.958606

8.958606 16.53

1.218242

11 compling 12 8.920819

8.920819

1.142668 13.89

12 8.886057

8.886057 11.85

2.073144

13 8.853872

8.853872

1.008774 10.2

14 8.823909

8.823909

0.984848 8.888

15 8.795880

8.795880

0.892790 7.812

16 8.769551

8.769551 6.92

0.846132

17 8.744727

8.744727

0.780414 6.173

18 8.721246

8.721246 5.54

0.743522

19 8.695770

8.695770

0.698970 5.-

20 8.677781 25 compling 26

8.677781 8.585026

0.656592 4.535 8.585026

0.471082 2.956

Log

Table cost of L.L.

Added eight inch wash rapra on the engineering of the making very handy Book

Table i

Cost H.P ½ ct. per hour

No of Hp per H.P	cost one hour	days 10 hour	annual 300 days	year 365 day
1	½ ct	5 cts	$1.50	$182.5.
2	1/4	2½	$.75	$9.125
3	1/6 ct	1⅔ cts	$.50	$6.083
4	1/8	1¼ cts.	$.375	$4.562½
5	1/10	1 ct	$.30	$3.05
6	1/12 ct	5/6 ct	$.25	$3.041
7	1/14	5/7	$.214	$2.607
8	1/16	5/8	$.186	$2.281
9	1/18	5/9	$.166	$2.027
10	1/20	1/2	$.15	$1.825

365 / 5 / 3118 / 5 / 985

365 / 4 / 3285

365 / 175 / 1825 / 2435 / 365 / 62675

365 / 125 / 1825 / 730 / 365 / 45625

365 / 225 / 1825 / 730 / 82125

$W = L \times a \times C \frac{t}{n}$

$L = 1$

$R = \frac{L}{a} C_R$

$C_W = \frac{W}{a}$ $\frac{189.07}{\frac{\pi}{4}(.25)^2}$

Log

200

Conductors

Table containing Sprague

1/8 in

Feet per Ohm

$R = \frac{L}{D^2} C$ $L = 1.000$ ft

$D = .25$ in

$R = .1654$

$\frac{.1654 \times (.25)^2}{1000} = C$

log .1654 = $\bar{1}.218536$

log .25 = $\bar{1}.397940$

log .25 = $\bar{1}.397940$

$\bar{2}.014416$

1000

316

100

2516

60

10337

1000000

1000000

comp. log. 1.0000 10.

$\bar{2}.218536$

$\bar{1}.397940$

$\bar{1}.397940$

$\bar{2}.014416$

$C = .0337$

or $10.336.5$

$\bar{2}.014416$

2516

014100

156

23

$\bar{2}.014399$

3/8 in log C =

comp log .375 $\bar{1}$ 10. 425969

.375 10. 425969

$\bar{2}.866297$

$\bar{2}.866297$

R =

$-\bar{1}.42$

$-((10-10)\bar{1}.42)$

$+(10-10+\bar{1}.42$

$11.\bar{4}2 - 10$

$11.\bar{4}2$

comply .125 $\bar{2}.014359$

comply .125 1903096

10.903096

$\bar{1}.820539$

6614

201

$R = \frac{L}{D^2} C$ $D = .25$

$L = 1$

$R = .1654$

$C = \frac{R D^2}{L} = R D^2$

6.52 / 1.42 (10 / 10 − 1.42) = 10

10.5 8 8

3/8 .375 10.
comp .375 10.

1/2 comp log .5 10.
.5 10.

~~28~~ $R = \frac{l}{s} C$ $l = 1$ ~~$s = .0625$~~

$R = \frac{l}{s} C$

$C = Rs$ $R = .1654$ $s = .0490$

log .1654 7.218536
.0490 2.690196
3.908622

810

8.014476 − 10
9.895090 − 10
3.709506
.0081202

2.014416
7.895090
3.709506

log C_R 189 2.276462
$R = \frac{c}{a}$ 2.698066

3/8 comp log .1104 10.

1/2 comp log .1963 10.

Weight = $l \times a \times C_w$ 2.276522
$C_w = \frac{W}{a} = \frac{189.07}{\frac{\pi}{4}(.25)^2}$ 10.104910
10.602060
log C_w = 3.585552
C_w = 3850.8 8421
91

1/8 ~~cond~~ Log .0122 — 2.086360
4807 — 1.671912
comp Log .0122 — 11.913648 − 10
.8499192
.5499192

Conductivity Lake Superior

892.57 June — $R = \frac{1}{C}$
100

$R = \frac{100}{92.57}$

3.909506
.033530
3.943036

2.
3.033530
10.033530
0.033530

$R_p = \frac{L}{a} c$

$R_{1/2} = \frac{100}{92} R_f$ — $C_{1/2} = \frac{100}{92} C$

$W_p = L a c$ — 2 | 5280 — 2640

3/8 Log .1104 — T.042969 — Weight
Cost two 885. — 2.628521 — 425.22
½ mile — 3.050125 — 1123.
comp Log .1104 — 10.957031 − 10
Ohms per 1000 ft — 2.900067 — .0794
feet per 1 Ohm — 1.099933+3 — 12588.
.2097 — T.321671
1/2 Log .1963 — T.292920 — 755.9
189 — 2.878472 — cost 8.13 per M
4 — 3.300176 — 1997.
756 — 10.707080 − 10
Ans — 2.650116 — .06311
.118 — T.071920 — 1.349884+3 — 22380.

5/8 Log .3068 — T.486855 — 1181.
Cost two 2.36. — 3.072407 — 3120.
½ — 3.446011
comp Log — 10.553145 − 10
.0754 — 2.877785 — 2.456181 — .02858
1.543819+3 — 34980.

3/4 Log .4417 — T.645127 — 1700.
Cost two 3.40 — 3.230679 — 4490.
½ — 3.652383
comp Log — 10.354873 − 10
.0524 — 2.719513 — 2.297909 — .01986
1.702091+3 — .50360.

7/8 Log .6013 — T.779091
Cost two 8463 — 3.364643 — 2315.
½ 4232 — 3.786247 — 6113.
10.220909 − 10
.0385 — 2.585549 — 2.163985 — .0145
1.836055+3 — 68550.

1 inch .7854

755 189
4 16
3020 1134
.0293 189
3078
1 1/8 2.486 7940

.0232 2.366254
1 1/4 1.227

.01882 2.275795
1 3/8 1.484

2.203206
1 1/2 1.767

.013 | 2.117403

7.8950 91 3024
3.4806 43 2063.
3.9022 47 4605.
10-10 4909-10 7984
2.0497 445 .01116
4.9520 55 89540.
1.9973 86
.5827 38 3827.
4.0695 72 10100.

10.0026 14-10
3.9456 50 .008823
9.0554 380 113300.
0.0884 57-10
3.6743 97 4724.
4.0960 01 12480

9.9111 55 =10 .007148
3.8549 19
5.1562 08 .14 3100.
0.1791 34 -10
3.7569 86 5714.
4.1785 90 15.086

9.8285 66 -10
3.7716 92 .005 91
5.2569 98 16900.
0.2472 37 .6892.
3.8327 89
4.2543 93 17.580

9.7527 63-10
3 6957 79 9.005692
8.3042 01 201.400

1 5/8 2.073

.0106 2.048041
1 3/4 2.405

.0096 2 | 3.983525
1 7/8 2.761

.00881 3.923574
2 miles 3.141
154
84 4.514224

3.867571
comp logs 280

0.3165 99
3.9021 51 7982.
4.3237 55 21170.

9.5834 04
3 6266 37 .001231
5.3735 67 236300.
0.3811 15
3.7666 67 9261
4.3882 71 24450

9.6185 85
3.5619 21 .003646
5.4380 79 274200.
0.4410 66
4.0266 18 10390.
4.4482 22 28070

9.5558 934
3.5019 70 .003176
5.4998 030 376300.
0.4770 68
4.0826 20 12100.
4.5596 224
4.7258 28
9.5029 32
3.4459 67 .002792
5.5540 33 358100.
6.2773 66
1.8313 99 67.8 miles

$2\frac{1}{8}$ 3.546 — 0.5497397 — 4.135291 — 13.970 — 4.556895 — 36.570

.00653 | 3.814801 + 4.5280 miles — 9.450261 — 3.393297 — .002473 — 5.606703 — 1.884069 — 76.4

$2\frac{1}{4}$ − 3.976 — 0.599446 — 4.184998 — 15.310. — 4.606602 — 40.430

.00588 | 3.765194 — 9.400554 — 3.393590 — .002205 — 5.656410 — 1.933776 — 85.85

$2\frac{3}{8}$ 4.430 — 0.6464404 — 4.231956 — 17.056. — 4.653560 — 45.030.

.005522 | 3.718235 — 9.353595 — 3.296631 — .00198 — 5.703369 — 1.980735 — 95.6

$2\frac{5}{8}$ $\frac{1}{2}$ 4.908 — 0.690905 — 4.276457 — 18.900 — 4.698061 — 49.890.

.00471 | 3.673734 — 9.309094 — 3.252130 — .001767 — 5.747870 — 2.025236 — 106.

$2\frac{5}{8}$ 5.411 — Wt 1000 ft — 0.7332781 — 4.3 i 88830 — 20.840. — 4.740437 — 4.166. — 9.266722 — 3.209758 — 55.010 — .00162 — 5.790241 — 2.067607 — .00427 | 3.631362 — 0.771373 — 116.8

$2\frac{3}{4}$ 5.939 — 4.359265 — 22.870 ✓ — 4.780869 — 59.000

.00390 | 3.590927 — 9.226287 — 3.169323 — .001478 — 5.830677 — 2.108043 — 128.5

$2\frac{7}{8}$ 6.491 — 0.8123212 — 4.397864 — 25,000. ✓ — 4.819668 — 65.980.

.003573 | 3.553327 — 9.187687 — 3.131723 — .00135-4 — 5.868277 — 2.145643 — 139.8

3. 7.068 — 0.8497297 — 4.434849 — 27.220 ✓ — 4.836453 — 5.445 — 71,850.

Coast 152.6 miles — .00327 | 3.513538 — 2.906261 — 9.150702 — 3.093738 — .00124 — 4.434849 — 7.841110 — 5.906261 — 2.183627 — 152.6

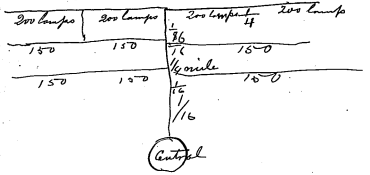
5 | 21.930000 — 8 4,386,000

3½	9.621	0.983220	
		4.568772	36.780
		4990376	94810.
		9.016780	
		4.961816	.000915
		6.038184	
		2.375550	205.8
		3.383420	.00241
4	12.56	2.098990	
		4.684542	48.360.
		5.106146	127600
		8.901010	
		4.844046	.000609
		6.155954	
		2.433220	271.2
		3.265650	.00184
5½	19.63	1.292920	
		4.878472	75.400
		5.300076	199.540
		8.707080	
		4.650116	.00446
		6.349884	
		2.427250	423.9
		3.071720	.00948

6	28.27	1.451326	
		5.036878	108.800
		5.454482	287.600
		8.548674	
		4.491710	.000 31
		6.508290	
		2.785656	610.1
		4.912314	.000817
10	78.54	1.895091	
		5.480443	302.400
		5.902247	798.500
		8.104909	
		4.047945	.000 111
		6.952054	
		3.227420	1695.
		4.969549	.000 394
12	113.6	2.055378	
		5.641930	438.000
		6.063634	1,155,000.
		7.944622	
		5.887658	.000077
		3.112342	
		3.387708	2452.
		4.309262	.000203

212

500 Ohms lamps.



500 1/10 Ohm to a lamp

Conductor maximum

500

1/10 Ohm to a lamp

Station

3/10 3/10

3/10 3/10 3/10 3/10 3/10 3/10

3/10 3/10 3/10 3/10 3/10 3/10

3/10 3/10 3/10 3/10 3/10 3/10

8)1500 3/10 3/10 3/10 3/10 3/10 3/10

3/10 3/10 3/10 3/10 3/10 3/10

3/10 3/10 3/10 3/10 3/10 3/10

At ½ mile 2640 ½
1320 ½
660 ½
330 ½
165

2640
2500
2000
1500
1320
1000
660
500
330
200
100
75
50
25

Size of wire
500

4000 : 1
3000 : 1

1/5 - 10 machines
10 | 200 lamps 20 | 500
50 25

10 lamps for
20 ~~H.P.~~ Mach
5 H.P. Machine

25 lamps $6.57
Machine $100 10. 100
10 $16.57
1000 10
Wire 10 20
130
Lamps 20 $13

Cost if
5 Lamps per H.P.
If 5 H.P. Machines cost say
$200
for each lamp $8 a year
80 ct
conductors 81 $6.57
.08.
Service $6.57

500 Ohm Lamps

100 500

Now is the winter of our discontent made glorious summer by this son of York. Now is the winter of our discontent made glorious summer by this son of York Now is the winter of our discontent made glorious summer by this son of York Now is the winter of our discon

500 Ohm Lamps

To figure out the resistance and cost of the lamps

Now is the

Give me

500 Ohms in lamps

200 lamps at end

How do you find 23
you do you 2 bove 2566394
you you c

14 500
77 L
2700 0
1013
1013
1017

218

15.43 Grains in one Gramme

Sprague 1000 Grammes in one kilo

7000 Grains in one lb.

15430 Grains in one kilo

2.204 lbs. in one kilo.

3.123851, Tlumpereed = 1.0-1.3217 about # Lamps White Light

6 60 miles.

7 69 miles

70

10 60

70

7 miles and 6 miles less

(16 7 miles on bike

2.25 bicycle

1008

Fathom = 6 feet Yale

Acre 220 X 198 ft 640 acres in mile

Kilo 2.204

Litre .908 1.0058

Metre 39.37 39.37

39.37

2.10

Hectare = 2.471

= 10000 mtr²

Acre = a 100 metres 19 yards

Centare

3.2808

220 X 198

328.08 or a metre

3960

396

43,560

220 X 198

220 X 198 220 X 198

220 X 198 220 X 198

220 X 198 220 X 198

220 X 198

220 X 198

Pennies

300 Ohm Lamps

~~10 lamps 30 Ohms~~
Conductor

10 lamps	30 Ohms in Conductor & Ma-
20 lamps	15 Ohms in " " "
30 lamps	3.33
40 lamps	2.5
50 lamps	2
60 lamps	1.66
70 lamps	

Each lamp regulated as 2000' is to 1389 ie. that when all ~~each~~ on the temp of each will be 1389 ~~K~~ multiplied by a constant When only one it will also be 1389 X C but 1/3 of the time will be regulated away

C

~~150~~

1389 occurs when the No of the lamps is 1/5 of the No expressing the ratio of resistance in the lamp to that in the machine, or the No of times greater the Lamp is the outside resistance

150 : 1 ~~K~~ 500 (3.33 ~~3.50~~ 200 350

300/500 (1.66

1 Lb of coal 11.228 ~~000~~ ft lbs.

1 H.P an hour for 1 33000 60 1980000) 11.228 (~~000~~ in. 11860

1/6 used

227

10 lamps 500 Ohms each

	Dia.	Ins	Weight	Cost
100				
200				
300				
400				
500				
600				
700				
800				
900				
1000				

223

10 clamps 50 Ohms in all

20 Ohms in Machine and Conductors. 100 ft

1/5 in conductors 2.5 Ohm

~~1/40~~ in house 1/20 in house

~~1/40~~ in street 3/20 in street

.2 Ohms from bus

.125 in house about .03 in diam

.375

$$k = \frac{L}{D^2} C \qquad D = \sqrt{\frac{L}{R} C}$$

$$D = \sqrt{\frac{L}{R} C} \qquad C = \frac{R D^2}{L}$$

$L = 4$ ft

$R = 103.365$

$D = .001$

$L = 1$ ft

$\frac{20}{5} = 4$

$\frac{100}{25} = 4$

2.014383

3

3

4.014383

$$\text{Area} = \frac{\pi D^2}{4}$$

Weight = L a C L in 1000 ft

$C = \frac{W}{La}$ Page 203

$= \frac{3850.8}{1000}$

Log 3.850 = 0.585552

Say 100 feet of conducting wire in each house then if there are 10 lamps in the house and the resistance that is when all on a resistance of 50 Ohms

So that only 1/3 shall be regulated away the resistance outside must not be greater than 20 Ohms 2)

If the transformers no regulation occurs when all are on.

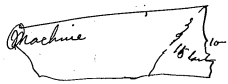
Then 10 Ohms outside.

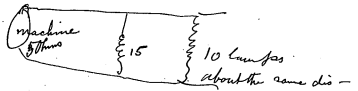
In the machine 4/5 or 16 Ohms.

Then in the five lamps for horse power and five horse power machines 20 lamps

There ought not to be more the 5 Ohms in a machine for the station required

1/50 an Ohm per lamp supplied if singly 25 lamps to a machine impossible





The lamps are all in multiple arc so the diagram is:

Inserting $\frac{1}{5}$

500 ohm / 50 lamps — 250 | 500 (2 Ohms

250 | 1 — 2 Ohms

If 50 lamps are 2 Ohms the outside

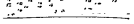
100 lamps — 1 "

$\frac{500}{500}$

10 lamps

$\frac{500}{50} = 10$ Ohms

5 Ohms



It is required that the resistance of all the lamps hereto when in multiple are be five times that of all the outside conductors so that when all are

on the temperature
shall give 1389 ~~Centigrade~~ units of heat when if only one were on without regulating it there would be only about ~~2000~~ 1995 degrees given off ~~20~~ that about 1/5 would ~~be certain~~ it would be needful to regulate away about 1/3 when only one lamp was on.

---

10 lamps total resistance
50 Ohms
1/5 of 50 = 10 Ohms

---

n = no lamps

$\frac{500}{n} = \frac{100}{n}$ equals resistance outside

25 lamps from a machine
~~20~~ 5 Ohms 1/5 Ohm to each lamp

---

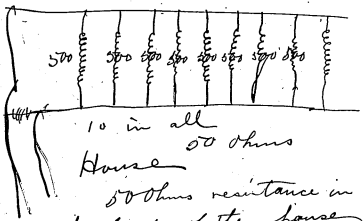
50 lamps
2 1/2 Ohms in machine
1/5 Ohm to a lamp

$\frac{2.5}{50} = \frac{1}{20}$ Ohm 5 Ohm machine and 1/2 impossible!
$\frac{100}{25}$ 4 Ohms outside

---

25 lamps from a machine
of 2 Ohms

$\frac{100}{25} = 4$ 4 Ohms outside.
1/2 in machine



10 in all
50 Ohms

House
50 Ohms resistance in the lamps of the house

At an expense of ____ dollars 100 feet of ____ wire may be put in each house for conducting wire having resistance of ____
1/4 in would cost $ 3.78.
R = .0165 Ohms
To the earth an equal amt making cost $ 7.56
R = .033 Ohms

The lamps in the house may
10 lamps may have
100/10 10 Ohms outside resistance so that

1/8 wire — 100 lamps in a house — 5 Ohms

say 250 feet will cost ~~$ 9.45~~ 4/47.27
5/11.81
$ 2.36
R =
4/.6615
.1654 Ohms

96 Book 31
286
122

2,204 lbs = kilo

39.37 inches in Metre

220 X 198 ft in acre

6 feet one fathom

69 miles 60 to a nice mile

7000 grains one lb

If 100 lamps in one house

total resistance 5 ohms

R 250 feet ⅛ wire .1654

R Machine .5

1.6654

Total resistance = 1.6654

Conductor .3346

or ⅓ in conductor or

1/15 of the resistance of all the lamps when in circuit in conductor.

100 Lamps must have only .3334 Ohms in conductor

100 feet away the conductor will have a diameter of — weight — and cost —

Conductor R R Conductor R R Conductor

The is in each house a certain amount of wire which is constant if we think of the houses as units it can be seen that double the number of houses will half the resistances and proportionally to obtain the same effect the whole resistance must be half that is or the no of machines and the cross section of the conducting wires must be doubled.

.3333 ohms

100 feet

$R = \frac{L}{D^2} C$

$1 = \frac{L}{D^2} C \quad L = 1$

$1 = \frac{C}{D^2} \quad 1 = \frac{L}{D^2}$

$D^2 = \frac{1}{D^2} \quad 1 = \frac{2}{D^2} \quad \frac{L}{a}$

$W = L \cdot a \cdot C$

$\log C = \bar{4}.014383$

$\bar{2}.000703$

$.61032$

$D = \sqrt{\frac{L}{R} C}$

2.33

$L = 100$

$R = .3333$

$\log C = \bar{4}.014383$

$\frac{2}{1.522444}$

$\bar{4}.014383 = \bar{3}.536827$

$\bar{2}.768413$

.05867 in diam

$\bar{3}.536827$

9.895096

$\bar{3}.431917$

.002703 area

$W = L a C$? = Page 224

$\log C = 0.5855552$

$L = 100$

$\log a = \bar{3}.431917$

$.5855552$

$.017469$

10.41 lt

20 cts

1/2 miles 2)5280
cost .20. 2640

1.421604
2.843208
69 T.y 1.041 0,1017469
$139. 2,8606677

725
$145 for 1/2 mile 1/3 ohm
200 lamps
$1450 for 1000 lamps
at 1/2 mile distance
1/15 in conductor as in lamps
1/5 in conductor than in lamps
1000 lamps
that is 1/3 $462
1/4 mile $115
1/5 mile $29.

$600.000 Cost
60000 ayear interst

50 ~~4000~~
~~200000~~ 60000
720 0
77
245800

1000 3 2000 200 2000
200

100 feet 100 lamps ~~[illegible]~~ conductor 1/15 of the resistance in the conductor than in the lamps or 1/3 Ohm.

a wire 100 ft long having 1/3 Ohm resistance will have a diameter of .05867 inches and a area of .002703
weighing 1.041
costing $ .1208 20 cts.

200 ft

$\frac{d(a^\theta)}{d\theta \log a}$

$\frac{d}{d\theta}\frac{a^\theta}{\log a}$

$\frac{a^{(\theta+\Delta\theta)} - a^\theta}{\Delta\theta}$

$\frac{f(x+\Delta x) - f(x)}{\Delta x}$

$\frac{a^{(\theta+\Delta\theta)} - a^\theta}{\Delta\theta} = a^\theta$

$\frac{a^{(x+\Delta x)} - a^x}{\Delta x} = a^{x+\Delta x}$

$a^x a^{\Delta x} - a^x$

$\frac{a^x(a^{\Delta x} - 1)}{\Delta x}$

$r = e^y$

$a^x = (e^y)^x$

$= e^{xy}$

$\frac{e^{z+\Delta z} - e^z}{\Delta z}$

$e^{z+\Delta z} - e^z =$

a a

$e^{z+\Delta z} - e^z$

$e^{z+\Delta z} - e^z$

$$\frac{e^{y+\Delta y} - e^{y}}{\Delta y} = e^{y}$$

$$\frac{a^{x+\Delta x} - a^{x}}{\Delta x}$$

$$a^{x} = e^{y x} = e^{y}$$

$$a = e^{y} \quad x = e^{y}$$

$$y = \log a$$

$$y = y^{x}$$

$$\frac{dy}{dx} = y = \log a$$

$$\frac{a^{x+dx} - a^{x}}{dx} \frac{dy}{dx} =$$

$$= a^{x} \log a$$

113
300
33.900
1728

20 cu ft

11.

One Litre H_2 weight 0.0896 Grammes

0.0896 Grammes,

1 Gramme H_2O

of 0.058 of H

log .1105-8 T. 042600
.0896 11.047692
.091292

1.23 litres
.61
1.84 litres

61.02 1.785715
1.84 0.264816
2.051569

113 cu in

34,462.
.11058
772.

4.5373740
1.0436000
2.5876174
6.4685914
4.1578104
1.3107810

33000 | 2914500

89.2

62,032
.772.
.11058
.0022

4.
2.
1̄.6468557
3̄.3424423

36.711000

5.140 ft. lbs. from one Gramme weight of H_2O formed.

47887,000
.0002
9,577.4000

Factor 62,032, 4.7923392
772: 2.0436000
.11058 1̄.8876174
.0022 3̄.3424423

4.066032

~~1,14000~~
11,400 ft. lbs energy in one pound of H_2O.
1/3 horse power to give 1.84 litres gas in one minute

If all the H.P.
were utilized 1.84 X 3
5.52

5.52 Litres from one H.P.
a minute of mixed gases.
or 3 Grammes

5.52
60
331.20 Litres an hour
About 331. Litres
180 Grammes

A.

Kilos. Metres.

24.577	4.390401
~~2.2046~~	0.342423
3.2809	0.515874
	5.248702
174.000	4.518514
	0.730188

135.4

1 Grain H

46.73 Cu. In.

46.73 1.66 9317

.11658 1.143370

4 .. .712687

2/5.16

2.58

7.84 cu. in. from a grain

480 grains = 1 oz

7000.

3500.

46.73 9 Grains 24

53.

138

200

2138

1069

3227 cu inches from 3 oz.

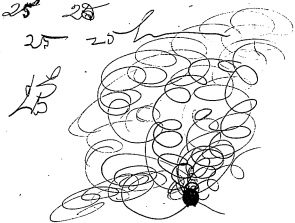
1728

1

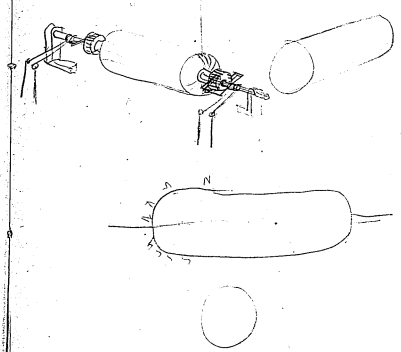
6

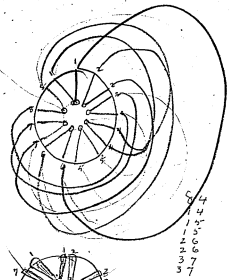
25 28

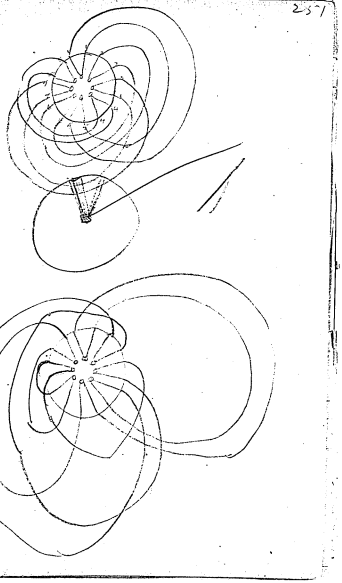
25 20

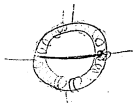


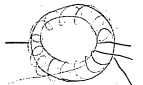
Pages 248 to 257."Dynamo Sketches." (Unimportant)

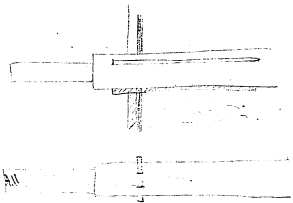












236
331
425
519
615
709
801
899
994
1088
1182
1279
1378
~~1890~~
1487
1574
1640
1746
1844
1940
2030
2130
2220

95
94
94
95
94
92
99
95
98
100
97
99
~~99~~
99
97
96
96
95
96
90
100
90

5718
4724
994

6800
5718
1082

7987
6800
1182

9261
7982
1279

10639
9261
1378

12096
10639
~~1390~~
1457

1.6744
15 1.1761
15 1.1761
4.0266

.13666 57
12096 13
1570

1744

17 1.6744
1.2304
1.2304
4.1356
35

1366 3.2) 21.0 (.6
15310 19.8
13670 1.2
1640

17056 18900
15310 17056
1746 1844

2 | 5280
2640
189.
499

.18
0.4216
2.2765
2.6981

4 | 498
124.5
9
1120

2.0951
.9542
3.0493

4490
4
17,960

6113
4
24,452

2.0958
1.1139
1.11139
4.3236

2107

2.0958

12.5 .8 57
.75 .0934
3.14 .4977
1.4661

2925 Jan 14 1879

Jan 21 2 no estimate
100 1000

15 Hours 1 cent

About the cost of 1 M ft per hour according to our estimate furnished us by B. from Manchester

The heating surface of gas is about [illegible]

$\frac{3}{32}$

.10

3.14

.314
.75
1570
2198
.23550

.125
.75
625
875
.93 75
3.14
37500
9375
2 81 25
29.43750

Orica Spirals .2,3
4.3 Spirals 6 am inch

Spiral gauge
2.5 Candles
4.3
7 5 Jan 14. 1879

Shorter spirals

3 red bright
4 yellow reddish yellow
5 yellow
6 yellowish white
7 white
8 full white
9
10
11
13 reduced
14 melted

.125
3.14
.75
Cog. 29

0.096
0.496
1.585
1.467

.0.28

1.480
.378

.23) 1.00 (4.3
.92
80

Watson Laboratory Note Book. No. 12.

Pages 201 to 280.

Notes on Platinum & other Metals & Potassio Oxid

See Watson Patents:

214,636	284,328
227,328	318,900
227,227	287,329

Area Spiral .2.3
4.3 Spirals to an inch

Spiral gave
2.5 Candles
4.3
7 5
10 0
10.75 for an inch

Jan. 14. 1879

5.5 & 5

.7740
.7740
.7480

.929
.929
1.858
1.480
.378

.23) 1.00 (4.3
92
80

Shorter afterwards

3 red bright
4 yellow reddish yel
5 yellow

1 5
1 4 melted

.125
3.14
.75
Coq. 2.9

0.096
0.496
1.875
1.467

.0.25

$L : C :: (7.25)^2 : (4.75)^2$

Candle	Lamp
4.75	7.25
.677	860
.677	860
1.354	1.720
	1.354
	.366

2.4

Spiral evaporated on hot day

Spiral color of

3 cells red

4 " full red

5 " reddish yellow

6 " yellow

7 " bright yellow

8 " yellowish white

9 " white with shade of yellow

10 " white in candle light

11 " full white

12 " white

13 "

14 " 2 candles required

010 Iridium } Spiral 10pc
Platinum }
Resistance 3.7

3 Cells — Red —
3 lines Inside the last spiral lines

4 Cells full Red
5 Cells Reddish Yellow
6 Cells Yellow
7 Cells Whitish Yellow
8 Cells Yellowish White
9 Cells White tinged yellow
10 Cells White
11 Cells full White
12 Bright White
13 Brilliant White 14 Intense White

12

Platinum Wire .004

Coil on 1 Cardboard Tube 6'

resistance 350 m m

2 Cells Carbon Full

3 ——— Rich Yellow

4 ——— Bright Yellow

5 ——— White

6 ——— Brilliant White

7 ——— Melts

4 Cells
Color Bright Yellow
Define – 8 —
Resist 10"

5 Cells
Color Yellowish White
Define
Resist

Platinum wire .004 Dec 14 1899
14 cells Chas Chandler
" 170 m.m. Melts
180 m.m. Deflection 21 12 ohms

Scarcely any permanent elongation

Platinum Iridium 20%
1 Cell
Deflection 3½
Resistance 6'4

2 Cells	3 Cells
Color Red	Color Yellow
Deflec 6½	Deflection 7
Resistance 6'7	Resistance 9'2

20/17 = 1.1
170 : 150 :: 180 : 159
150 : 10·5 :: 180 : 189
189 ÷ 10·5 = 18
1512 ÷ 126 = 12

14°

15½ - 7.9
16½ - 8.4
17½ - 8.4
18½ - 9
19½ - 9.2
20½ - 9.5
21 - 9.9

14

1" = 1 ace = 5/16 = 7.94
= 2 " = 8½ = 4.9
= 3 " = 11 = 5.4
6.5

.75
1"
13.0
.75

$$\mathcal{I} = \frac{\mathcal{E}}{R + R + \mathcal{S}} = \frac{\mathcal{E}}{R + \frac{(R+\mathcal{S})}{R+R+\mathcal{S}}}$$

$$= \frac{\mathcal{E}}{R + \frac{R+\mathcal{S}}{2R+\mathcal{S}}(R+\mathcal{S})}$$

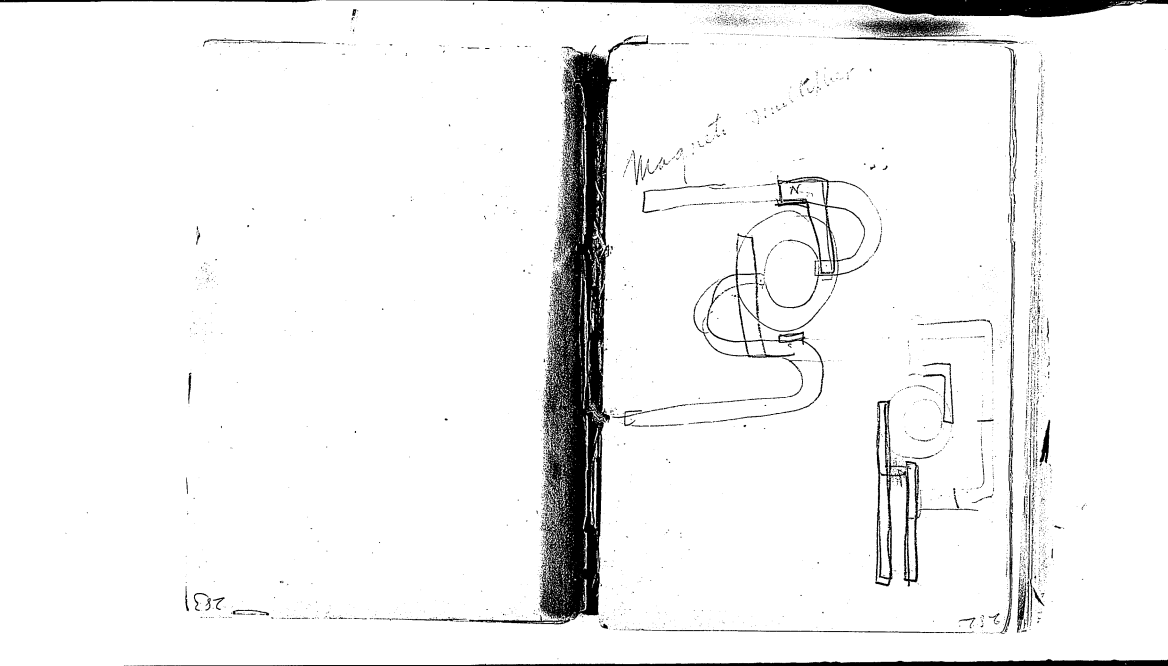
$$\therefore R + \frac{R^2 + R\mathcal{S} + R\mathcal{S} + \mathcal{S}^2}{R(2R+\mathcal{S})} = R + R - \mathcal{S}$$

$$I = N - V = R$$

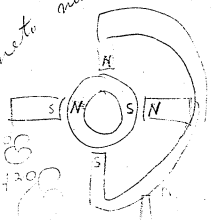
Size of wire 1
Length of wire 2
No of Coils 3
Deflection 4 Chas Batchelor
Resistance 5 Chas Batchelor
Deflec^{n} X Resis 7
Volts & Curves ^{2}X R ccs. 8
Horse When used 9 8.Y3 6.1
Remarks 10
Color 6 8.5

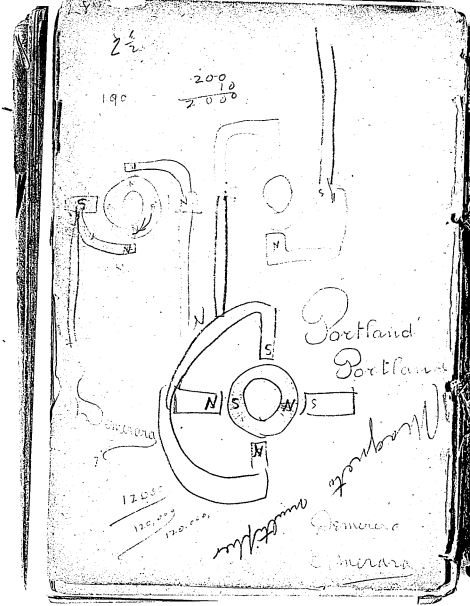
Chas Batchelor 8.9 6.8 11
Chas Batchelor 9 6.1

10.5


Magnetic Induction
N

Magneto multiplier




N
S
Portland
Portland
Connecticut
Connecticut

Menlo Park Notebook #13 [N-79-01-01]

This notebook covers the period January-July 1879. Most of the entries are by Charles Batchelor. There are also entries by Edison, Francis Upton, and John Kruesi. Many entries are signed by Edison. Almost all of the material relates to experiments on electric lighting. Included are a caveat by Edison on generators; notes, drawings, and calculations about generators; and drawings of lamps. There are also drawings of telephones, notes by Batchelor on the design of a building to house an engine, and a note by Kruesi on a water tank. The label on the front cover is marked "Edison's First Magneto." The book contains 232 numbered pages followed by 2 unnumbered pages.

Blank pages not filmed: 6-7, 10-11, 130-131, 188-189, 198-199.

1110 13.

LIBRARY OF THE

BOARD OF PATENT CONTROL,

120 BROADWAY, NEW YORK.

_____, 189 .

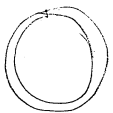
1013 4 in 3. ft ft long
½ inch thick

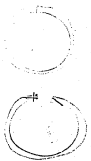
37 19

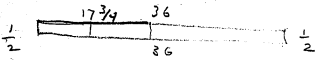
137

1
1
2

4135
9.







3

3 feet $\frac{1}{2}$

37 ~~feet~~ inches

2

73

2

3 | 71

35

72

1

73

2 | 36.5

18.25

5-0

2 | 17.75

17.75

50

17.25

$\frac{1}{15}$

$AB + BE = \frac{1}{2}(AB + BC) -$

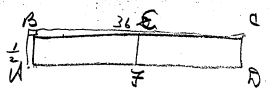
16 × 9 = 144 + 72 = 432

16 × 9.2 = 152 + 7 = 1.3.1.0

3 × 3.42 = 10.26

34.2

54.72



$AB + BC$

~~$AB + BE = \frac{1}{2} AC$~~

$AB + BE = \frac{1}{2}(AB + BC)$

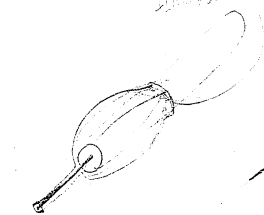
$BE = \frac{1}{2}(BC - AB)$

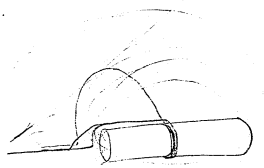
4.062 × 5 = 35.56 ÷ 2 = 17.78

36.5 × 5 = 35.5 ÷ 2 = 17.75 × 5 = 17.25 ÷ 2 = 8.625 × 5 = 8.125 ÷ 2 = 4.062

8

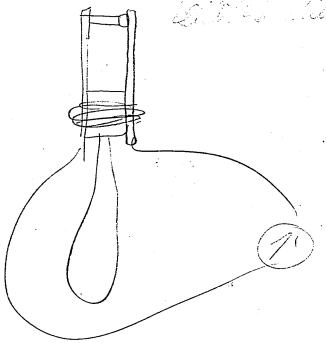
Jany 1 1879
TAE





9

Jany 1 79
TAE

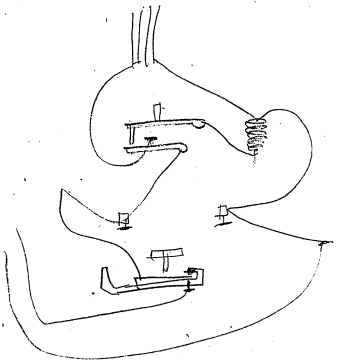


12

13

January 1 1879 T & E

Winchester



14

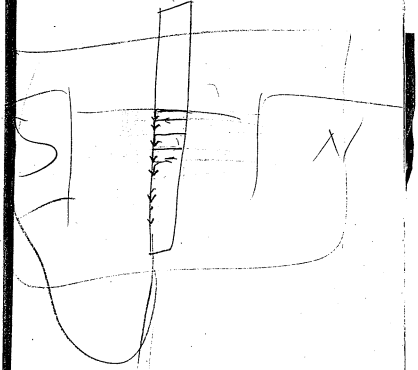
Northland

Northland

Northland

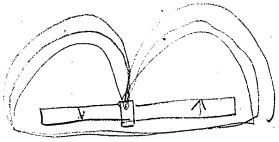
15

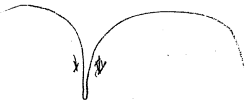
Jany 1/79
-TAE



January 1 1879

TAE

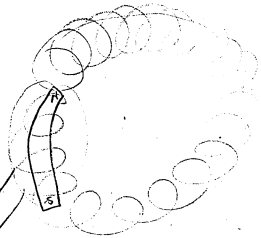


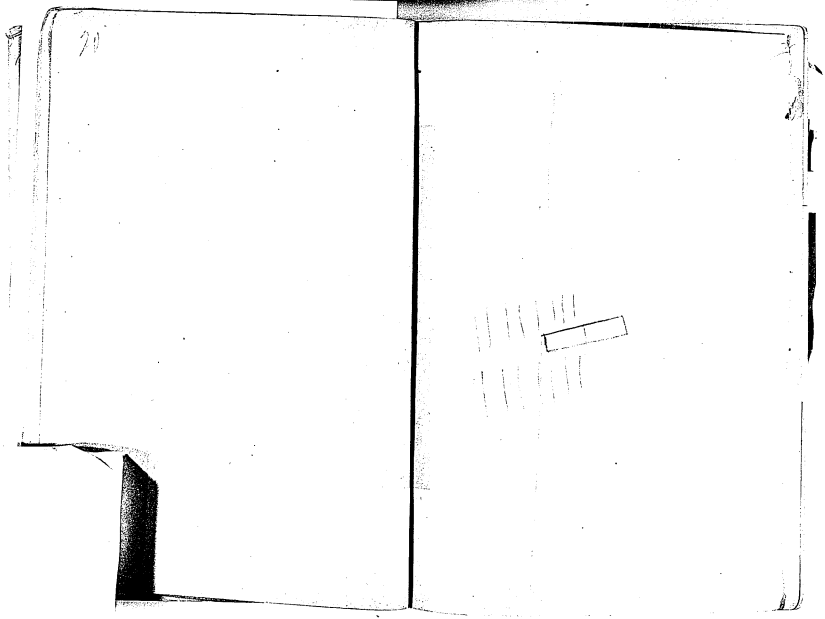


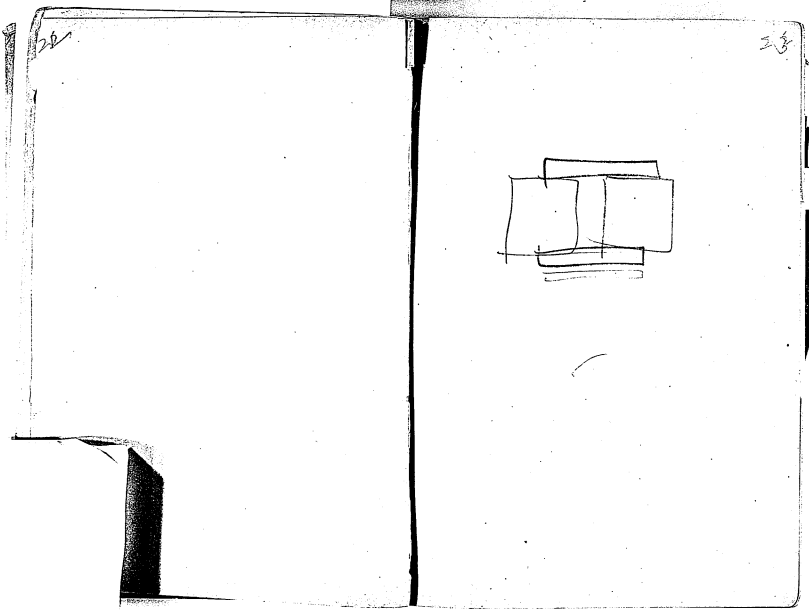
18

19

January 1 1879
FAE







Notes on the making of Jan 1st 1893
Edison's New Magnetic Electric Chemical Tattler
Generator

TAE

/ Commutator :-

Must be finely divided 3/4 of an inch 4 to an inch

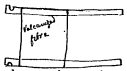
Must be fixed with double commutator
Springs so that one pair can be lifted
and that part cleaned without stopping

Must be fixed so that the dirt will drop through

Must be about 3 inch long -

Commutator and brushes must be
made of the metal that will give the
least arc when in circuit with
a battery of 8 or 10 carbon cells and
a large coarse wire magnet

Commutators must be made of
metal drawn in shape and each length
has a groove in end to hook
the bared wire on;
these are drawn into a



disc piece of vulcanized fibre, turned off and
the wire soldered to the metal

7/8 26 wire

Diameter of wire .018 inch

1000 feet = .980 lbs

1 Ohm = 31.3 feet

Number of turns per inch 56

Length of 1 turn 43 inches

Number of layers 4

Total number of turns 224

Total length 802 feet

= Each coil = 56 turns × 26 ohms = 224 turns

4 layers

Inch wide

Straw

.018
.018
144
64
224
43
172
86
802
313/802
51
26
182
156
26
.980
3
2940
49
2940

January 1 1879

Tae

16
2
2
16

21
21
645/8
5260

26.

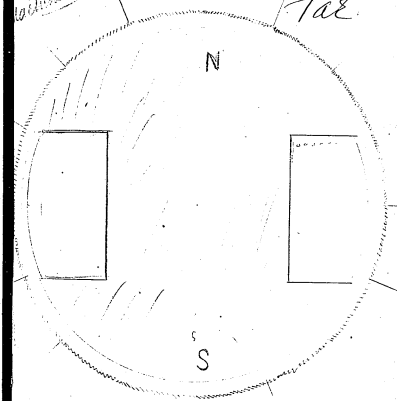
Jan 3 1878

New Machine Jan 3 1878 39
Chas Sawtell
Tax.

Ring to be wound
with 26 wire, each spool
1 inch long + 4 layers
which will give 645 feet
of ~~#40~~ 21 wire to each
spool = 4 spools in circuit
at once =
Total number of coils
160 ohms and contain
5·19 lbs wire

30

Jan 8 1779 31



Mr. Jack Mechanic Jan 3 1879 33

Illustration

As shown on page ahead
there will be only 6 coils
in position marked 7
this will give joint resistance
of 3½ ohms
Armature must be 4 ohms
to do this we must use
600 turns of No 16 wire
give 4 9/10 ohms

Sectional Area Round wire $\frac{\pi}{4}$ sq in
armature wire = $2 \times .78 = 2.24$

each turn is 4 inches

16 wire 407 ft 1 ohm it would have to be 1628 feet long this would have to be coiled only 480 times it would however coil about 610

12 wire 1160 feet 1 ohm it would have to be 4600 feet long this would have to be coiled 115 times

14 wire 660 ft 1 ohm it would have to be 2640 feet long coiled in 40 inch

16 wire 170 feet 1 ohm it would have to be 680 feet long coiled in 40 inch

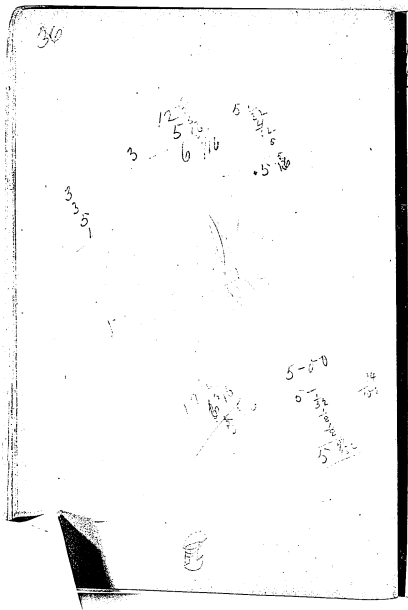
15 wire 501 feet = 1 ohm

2004 feet = 4 ohms

should fill in 600

15 wire 560 turns will fill $3\frac{1}{10}$ ohms

16 wire 600 turns will fill $4\frac{9}{10}$ ohms



Vapor Machine Jan 3 1927
Chas. E. Eckels

Finally
the Armature must be
5" diameter iron
Air space 1/32
Shell 1/16
Wire space 7/100
outside cast iron rings 3 3/32
Making 12.5 inches in toto

See further

38

1000

166 2/3

12 | 24 | 12
12 | 12 | 6 = 72

12 | 24 | 12 | 12 | 6

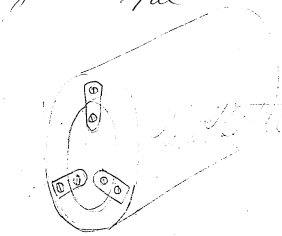
166 2/3

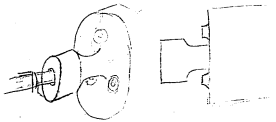
37 1/2

37 1/2

37 1/2

January 3 1879
TAE

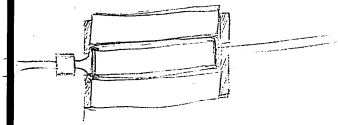




Edwards
Mag. Box Machine

Jan 4th 1870
Chas Batchelder

Make pieces on ends to cut the ends of box by ends of wires as in—



$2.50 = \frac{300}{4} = 9^{0}$

$\frac{300}{2} = 150$

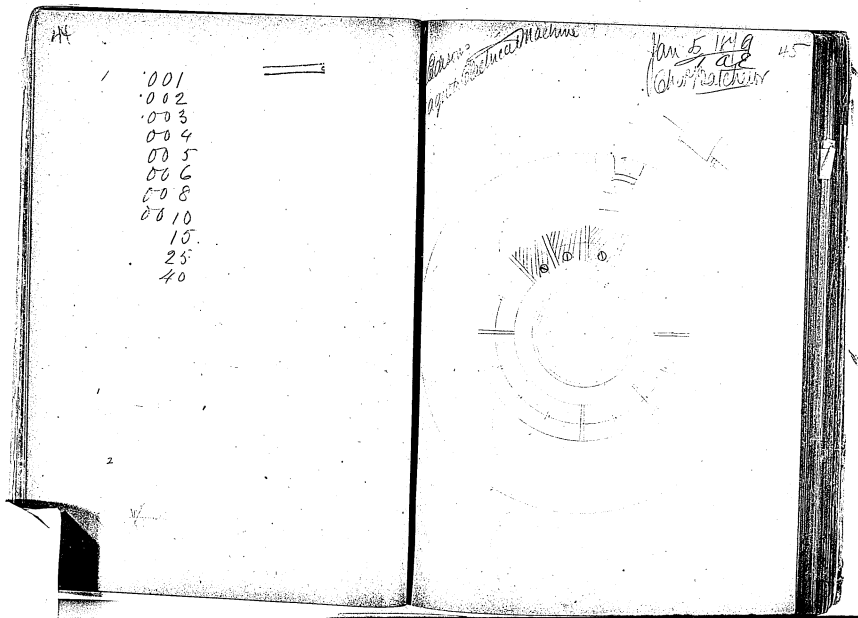
$\frac{75}{19}$ $\frac{75}{3}$ $\frac{3}{16}$

$.250 = \frac{1}{4}$

$\frac{1}{64}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$

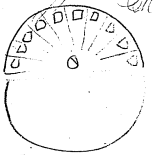
4 4

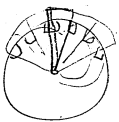
1 1

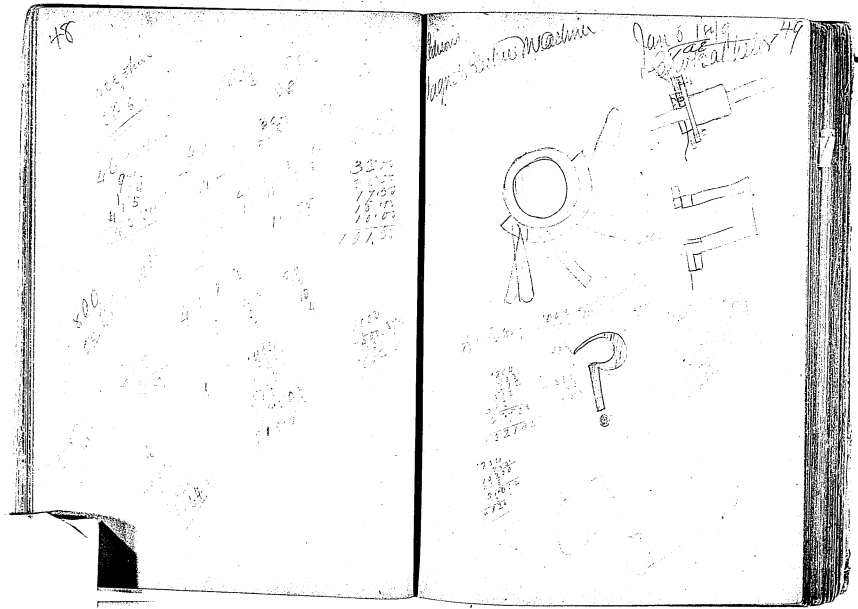

001
002
003
004
005
006
008
010
15
25
40

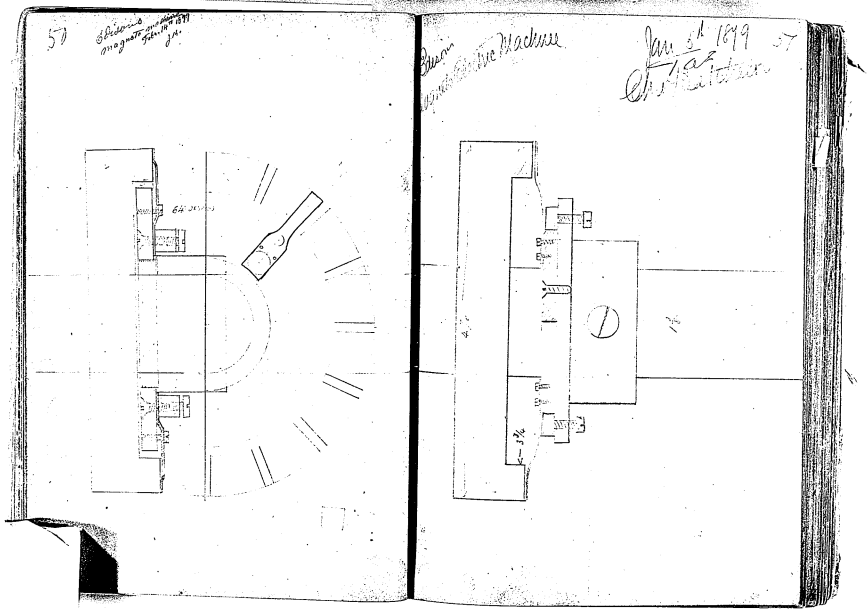
January 5th 1879

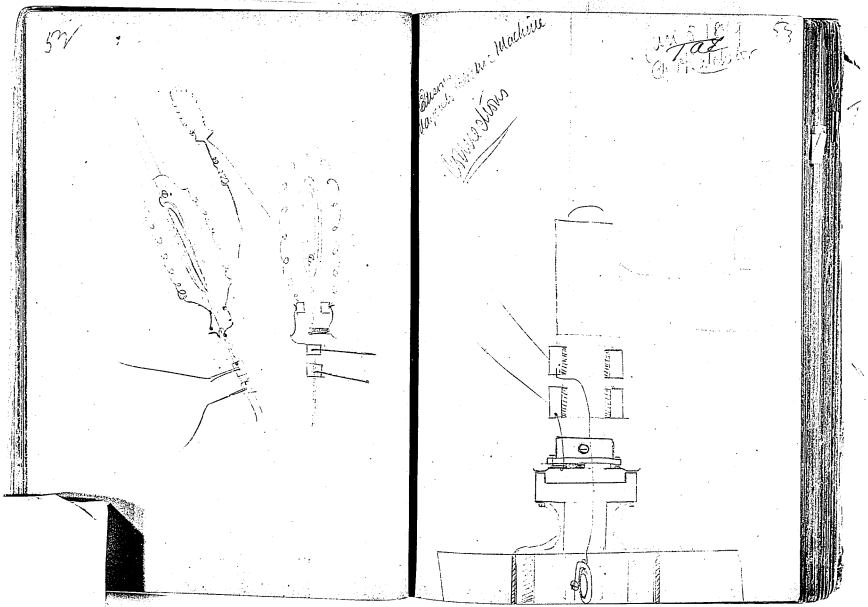
TAE





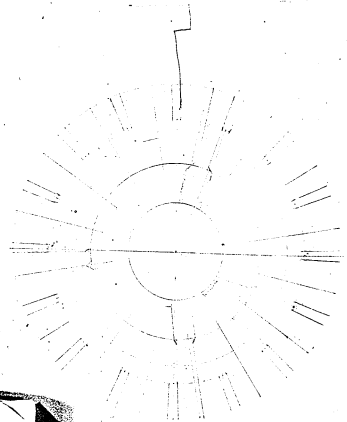


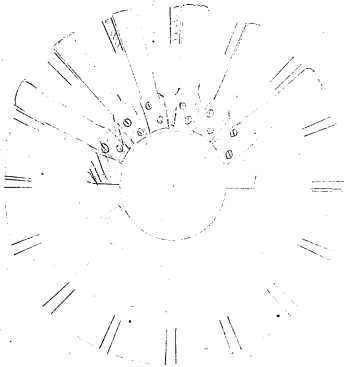




Edison's Magnetic Telephone Mach

June 6 1879
Edward Postlethwaite

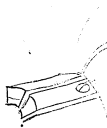


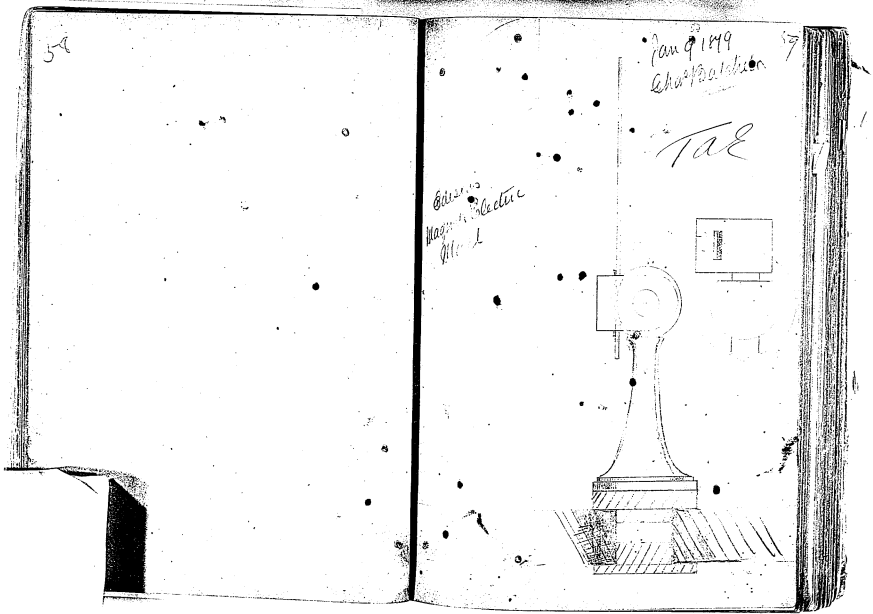


Jan 6th 1874 Tate

Have Orders 6th 26 Sail

And 25th & 16 Cots

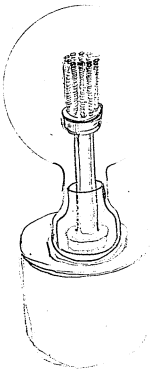



58
Jan 9 1849
Chas Backus
TAE
57

60

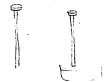
61

January 6th 1879



6r

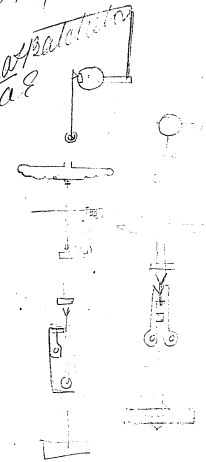
Jany 6 1879



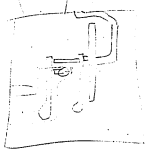
64

Jany 6 1879

* Chronometer
Tate

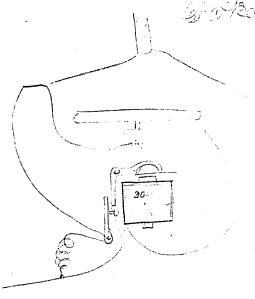


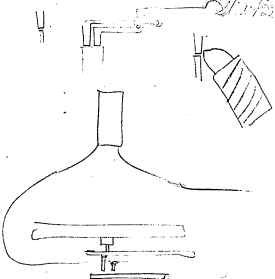
January 6
1879
Tae



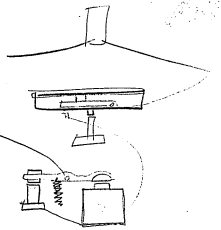
January 6 1879

T & E

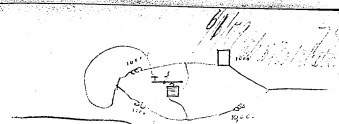


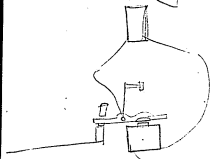


January 6 1879
TAE



January 6 1879 10 T&E





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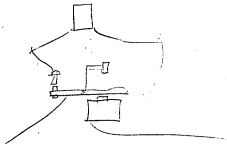
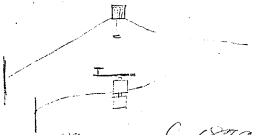
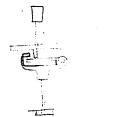
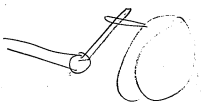
TAE

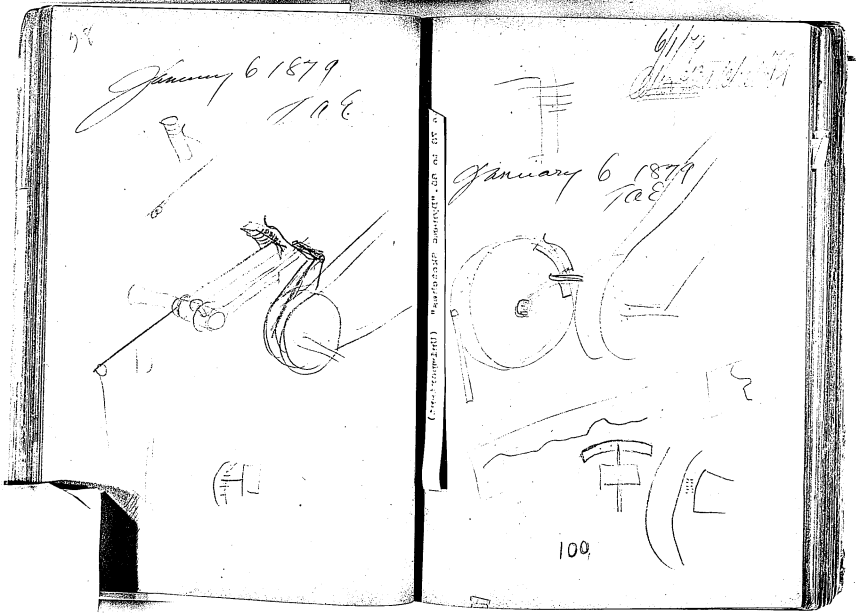


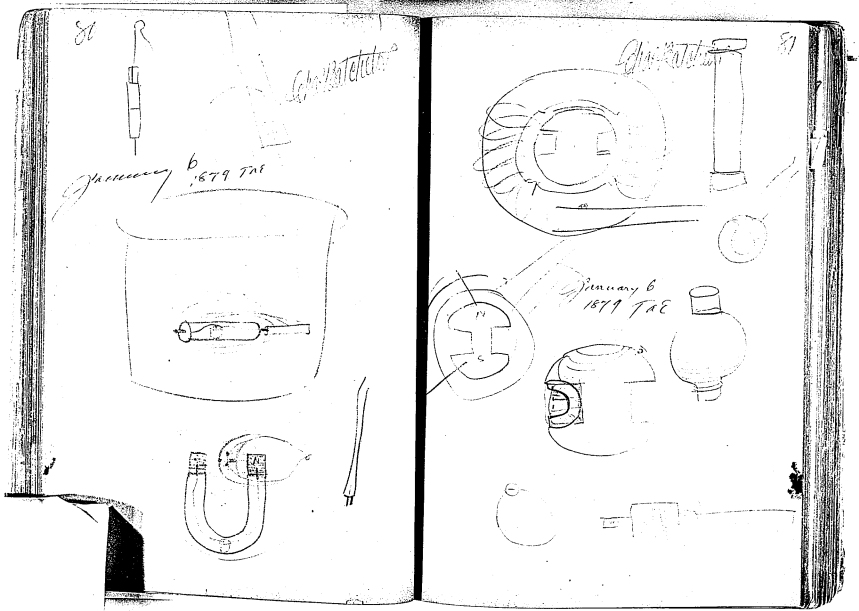


January 6 1879 Tat






January 6 1879
January 6 1879
100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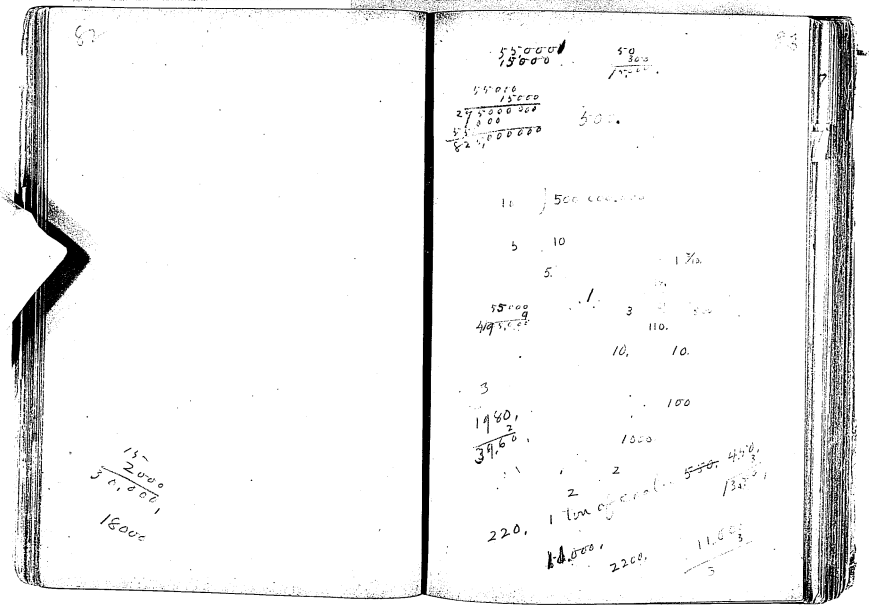
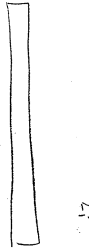


84

group 6
1879 Ties



25 9 in.
25 17 D. "
25
194

9-9
34

1/8 X 3 X 5

Partition for Closet in top floor

Partition for bottom floor.

Height

Size of Glass January 6

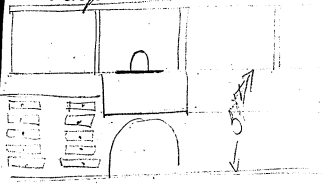
Height of woodwork 1879

Style of woodwork

Length of partition Tat

Door in partition

Ridgeboard



15 Windows
2 Doors
142 Sliding feet
Walnut panels and wood

1855

Partition for Closet
Ash + Walnut
Paneled
Outside partition + door Ash +
Walnut. Inside panels Pine
With ground Glass

January 6 1879 Taft

must be cut 15.7 when cold

15.7 = when hot = ~~15.897~~ 15.944

5 : 8

5.0625 5.1

.0625 .0156 1.5625 15.625 15

15.7

.0156 .0156 .0156 .0156

15.7 15.7 15.7 15.7

Shell — June 6 1879

Annature 5. in Face

Airspace 1/32 = 5 1/16 inside

Shell 1/16 = 5 3/16 outside

.5 1/16

.5 3/16

Mc Hill must be

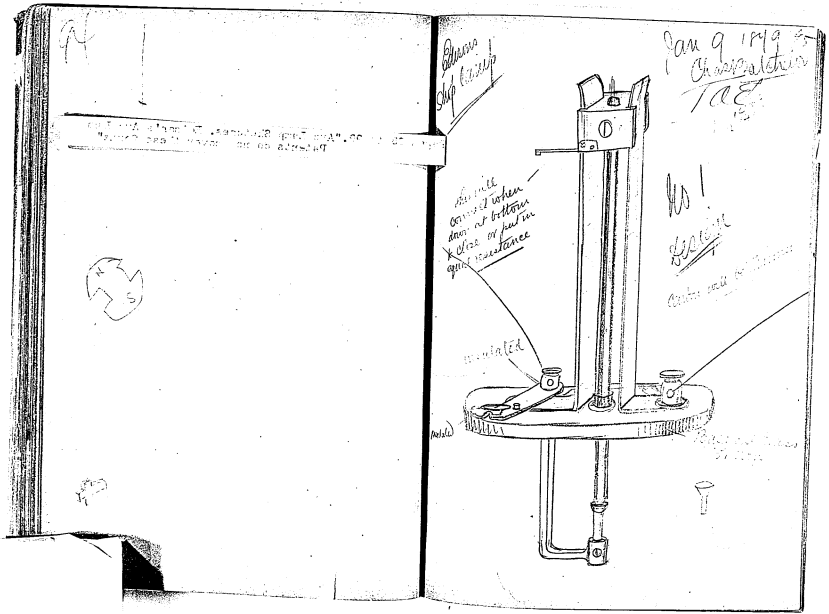
9

b outside 3.4

Shell for Edisons Magnet Machine

Made in centric of 3 pieces when put together [illegible] shell and the shell [illegible] rivet together and then shrunk on mandrel & [illegible]

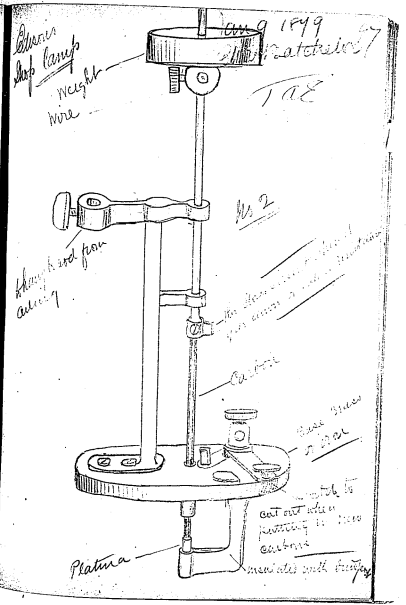
January 6 1879
TAE



Aug 9 1849

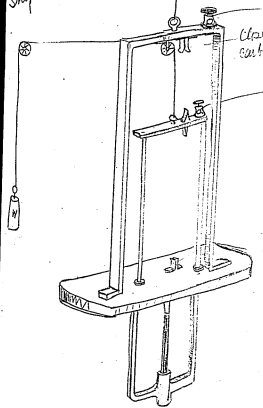
Catcheside

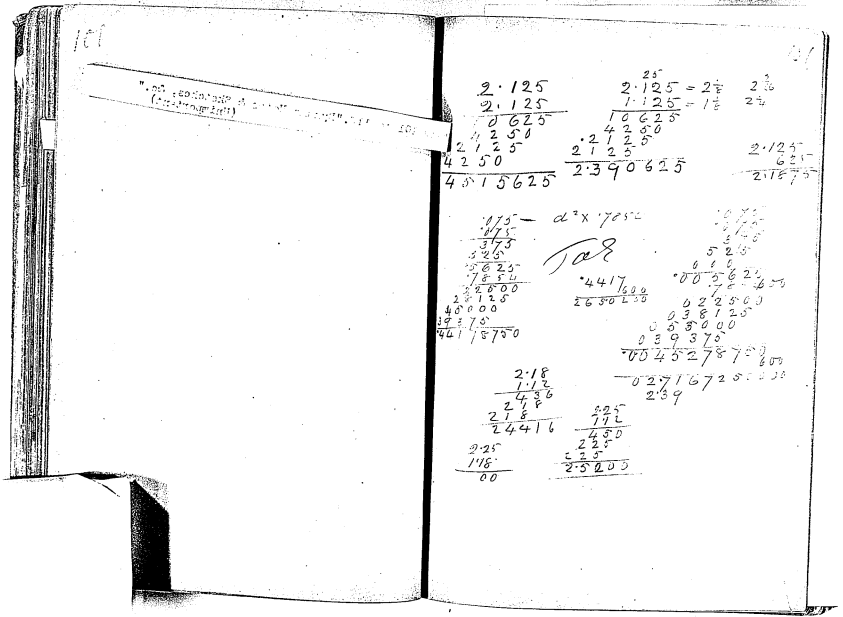
TAB

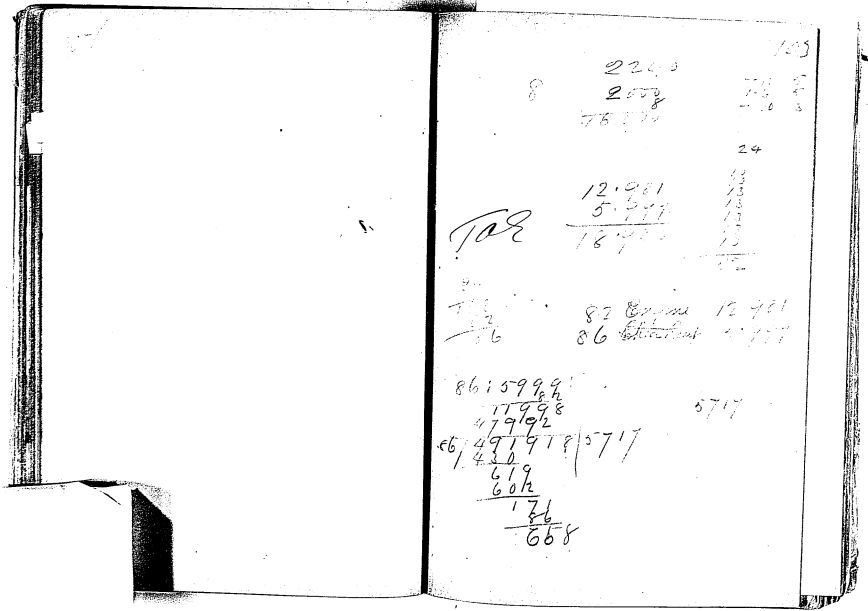


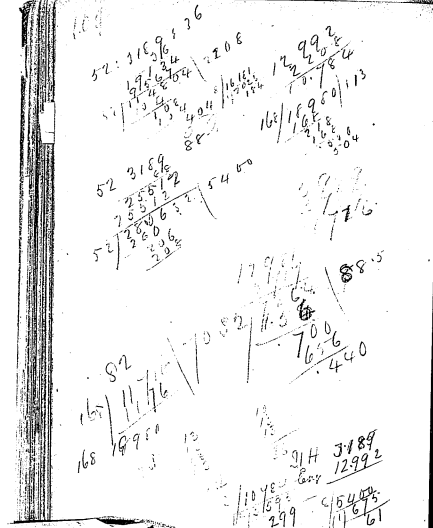
Electric Shelf Clamp

Jan 9 1899









Week Jan 10 & Jan 17

Engine running + Steam heat 12,981

Steam heating 86 = 5,999

Steam heating 86 + 82 = 5,999 + 5,717 = 11,716 lbs

Engine 82 hours

12,981 − 5,717 = 7264 lbs =

88.5 lbs per hour - Tar

Steam heating =

86 + 82 = 168 = 70 lbs per hour

Jan 3 — 10 1919

Engine Runn + Steam heating, 82 hours =

161 lbs coal

Engine 36 = 12,992

Steam H. 82 = 31,89

161,89

Steam H — 88 = 5400 61 lbs per hour

Engine = 36 - 10784 = 299 lbs per hour

Jan. 20th 1894

J.M.

T.A.E.

Water Tank Calculations

Space Standard Wheel Chair = 5'-6" x 2'-6" = 13.75 sq ft

Weight of Water = 5946.875 lbs

Normal Tank — 44'-6" x 4'-0" x 4'-0"

Weight — 44'-8" x 4'-0" x 4'-0" x 62.5 lbs = 44800 lbs

Capacity Gross 1043.5 Cu ft

Weight 10465.5 Cu ft x 62.5 lbs = 654093.75 lbs

Inside Surface of Tank 181.04 Sq ft

Steel Lining 4 Coats 724.16 Sq ft

at 8 ¢ per Sq ft $57.93

Labor for Tank $10.00

$67.93

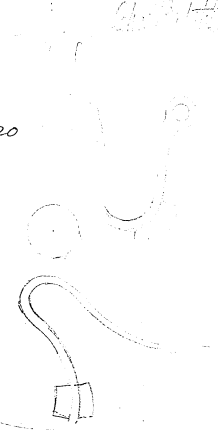
10th Lo outside 3.4
inside 8.4
11.8

From outside wires
to inside 6.8

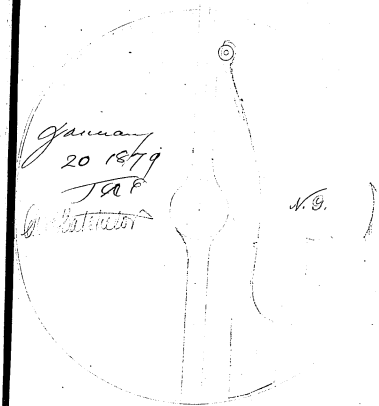
8.5

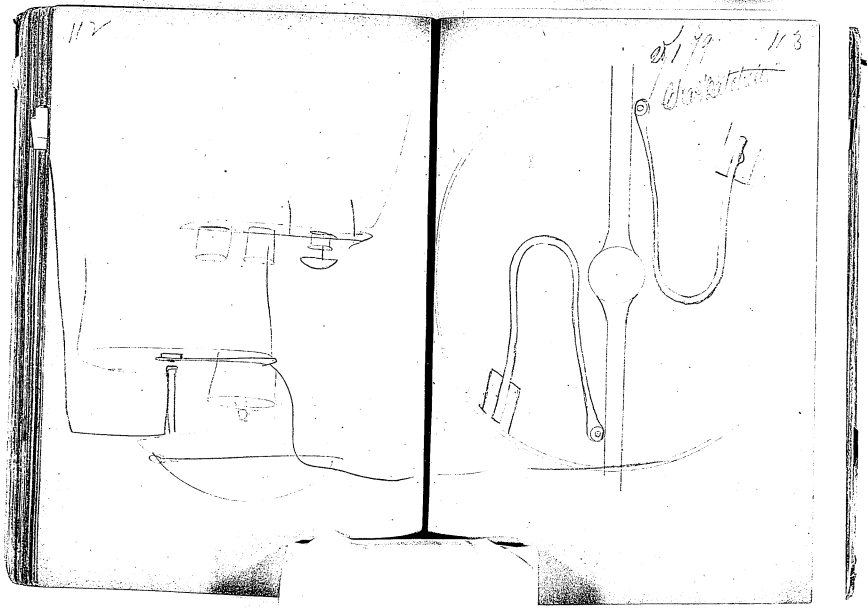
to the inside 2.3

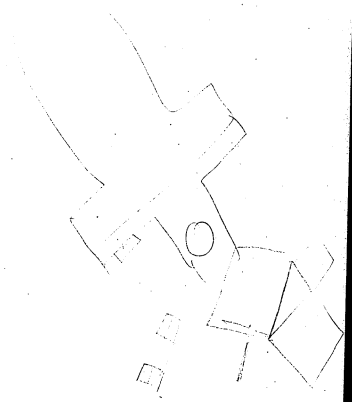
Gramm 20
879
Jag



January
20 1879
JAF
Illustration

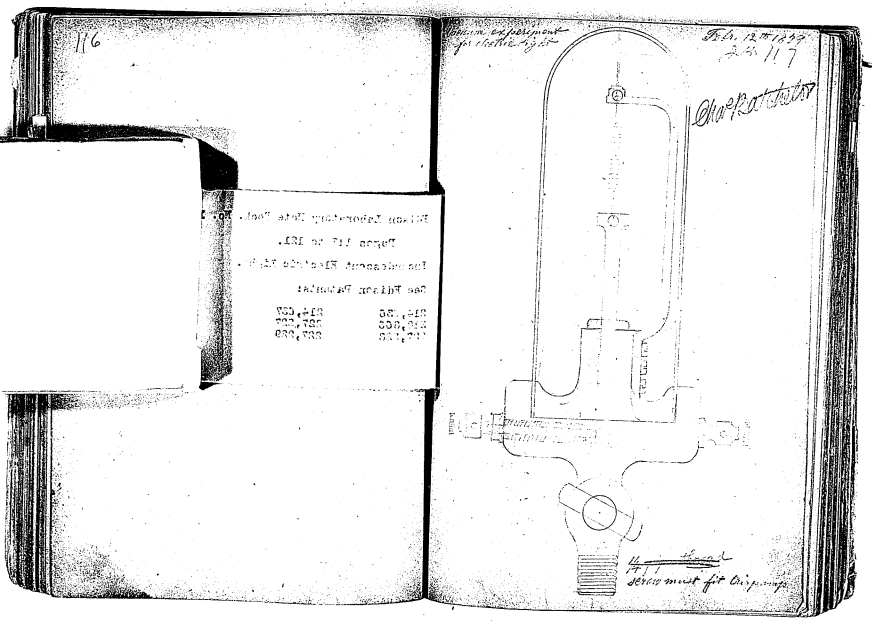


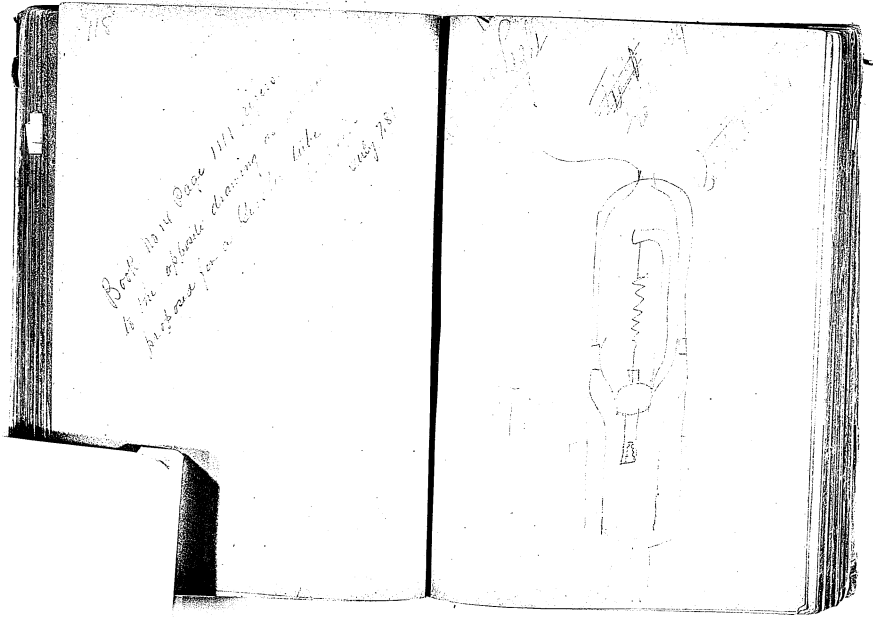


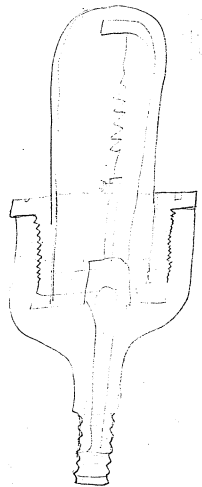


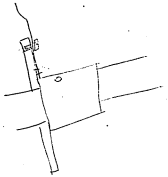
Weight of wire on armature for Dynamo Electric Machine 9 lbs 14 oz

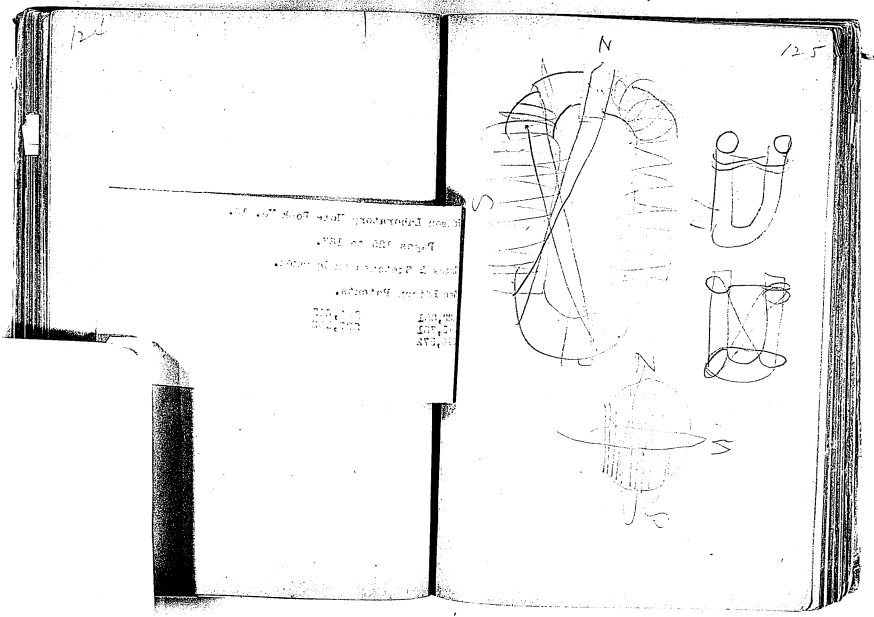
Weight of armature shaft & pulley Standard on 51 lbs.

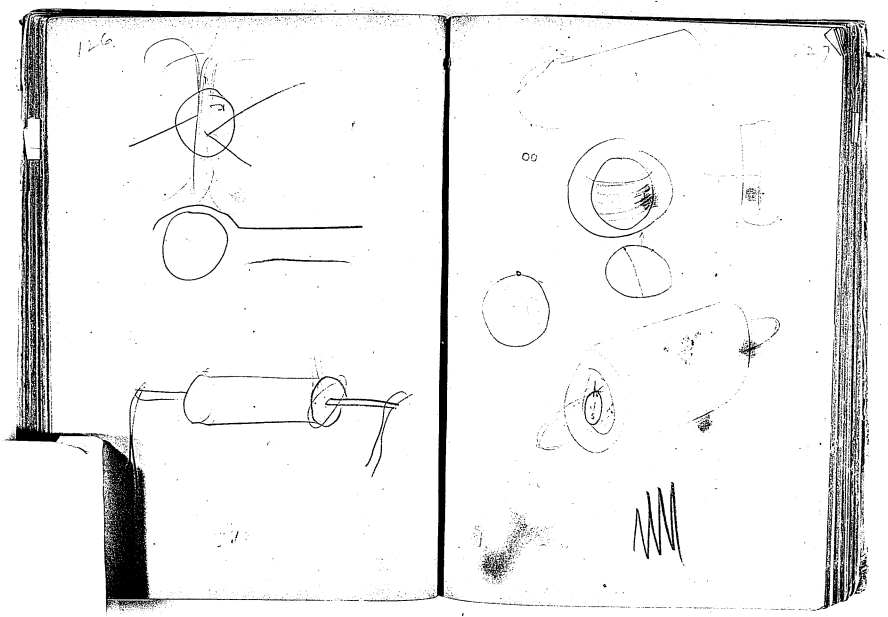

116
Feb. 12th 1929
2,701,117
Inventor
Witness

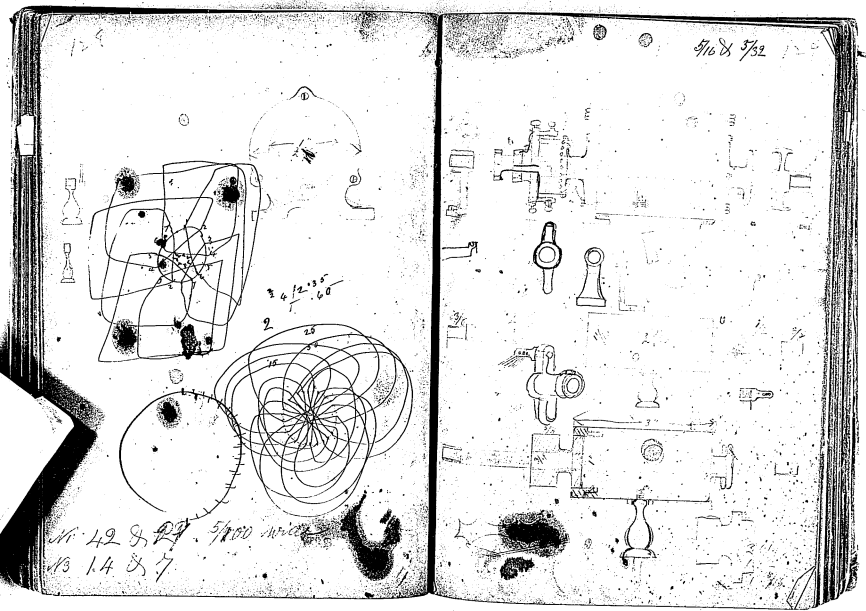







N
12.5
N
S

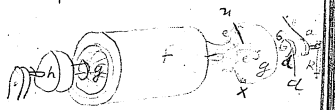



5/16 & 5/32
#4 12-3 5-60
2
#1 42 & 27 5/100 inch
#3 14 & 7

The aGreed on the Conditions to
to governe Wilkins Patent
by the appointment of
The invention Consists 1
1st In the method of winding
and Connecting the wire
the Commutator.
2nd in the method of
the Governor -
3rd The method of operating
the Current by
the Cords of gut and
Causing the them to cut the
wire while standing still

4. The use as a armature to the field magnet consists of a sheet copper ~~tube~~ washer [illegible] separated from the armature

Fig 1



f is the cylinder within which the ~~armature~~ wire brushes are placed. The Cylinder is made up of [illegible]

Number of discs clamped together by three rods. These discs are mounted on Each of them is pasted paper upon their sides. The object of the invention is to prevent the ~~fault~~ current from circulating within the iron ~~This fault~~ I will mention that this invention may be made by cutting away one or the pieces of which will prevent to a greater extent the formation of eddies.

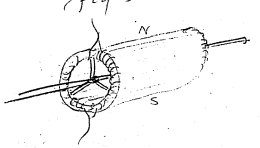
Converts, but is more
Expensive.

fig 2

In fig 2 is shown the
field magnet
which consists of coil
wound on soft iron
closed, when
The core is wound
over its entire
starting from any

points two wound under [illegible]
the Ending wire is [illegible]
with the [illegible]
Here two [illegible]
cotton by inserting wire
[illegible] to two [illegible]
hinge on the shaft
The wires being bent in [illegible]
cut on the shaft = [illegible]
The form of the [illegible] quill cut
in fig 3 may also be used

fig 3

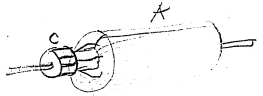


nifigure 3 the fuse consists of a cylinder of iron or iron wire wound in the form of a cylinder, ~~two separate~~ Coils of wire are wound on it, brass arms at each end connect it to the shaft which rotates it =
Two separate coils of wire are wound around the shell passing over the top & bottom, these underneath, these wire coils are wound longitudinally and the two extremities of the coils are connected together as well as the two extremities on the other side — ~~of the~~

~~Current to pa~~

If these ends be connected
to a source of Electric
Energy the ~~p~~ iron shell at
the point where the wires are
connected become respectively
the N. & S. poles of the magnet
Whether either the form of magnet
shown in fig 2 or 3 is
mounted and revolved within
the ~~of the~~ cylinder of discs
it causes to field ~~of~~ without
decreasing the polarity of
the Cylinder of discs
at each revolution.

between the cylinder and the revolving field magnet of figs 2 & 3. is the shell ~~fig~~ A shown in fig. 4.



The shell is made of Vulcanized fibre about 1/16 thick and the ends are either non metallic or if metallic must be of nickalline wire if attention is paid to the prevention of the circulation of any currents

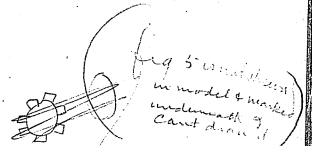
which might be induced 149
into it.

~~The field magnet~~ the wires are wound over the shell (right) and are connected to the blocks (left) of the commutator C in a manner to be hereafter described.

Within this shell the field magnet revolves. The combination forming a compact machine in which the concentration of the field is very great, and the magnetic resistance of the iron of the magnetic circuit very slow

and where every line of force must cut the wire upon the shell K. This utilizing the whole field, which is of the great economy as it requires expenditure of energy, to form the field. and if ~~from a point~~ a ~~point~~ of the lines of force do not cut the wire, then to that extent is energy lost. I will now describe a new and useful method of winding the wire and a coil ~~for~~ the commutator ~~and~~ ~~the~~ ~~winding~~ ~~of the wire~~ ~~and no part of the~~

the loss of energy by short circuiting within the machine reduced to a minimum.



~~Suppose~~ fig refers to fig 5 and consists of the commutator provided to fig resting upon the brackets 1 + 5

and the ~~top~~ field magnet with has its north pole on top & its south pole below

bottom then the current from
the brush resting on block
I would go via wires ~~1 to~~
~~the north pole~~ [illegible]
~~S of 13~~ 14.6, North pole
returning by wires 8 4 13
over south pole. thence
over the north pole by
wires 3 4 ~~12~~ returning
over the south pole
by wires 10 & 11. thence over
the north pole by wires
5, 4, 2. then returning under
the south pole by
9 & 12. the 9 being
* connected to the brush
5 upon which each

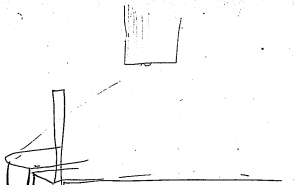
Communicate by such rest
hence with a double wire
circuit. the wire 12
proceeds to Owen the
N with pole by no 7
wire, thence 6 under
7 South [illegible] the
other wire of Communic
6 Clock. 5. This coil
is at the water side pump
station the north
South pole of which
runs a short distance
the ground here is of no
use to short circuit
the Grounds are reversed
to 6 Clock 7.4 6. The
same Commutation or Current

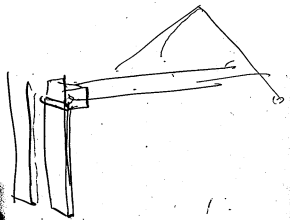
4 formed but by an alternate
set of wires, so that no
matter what the position
of the brushes a complete
circuit is formed cutting
all the lines of force.
The Commutation can only
be attained by employing
an odd number of coils
4 an odd number of
blocks, the method of
the use of an odd number
of blocks
so that the wires may be
in circuit at all
the commutator the
novelty of the part of

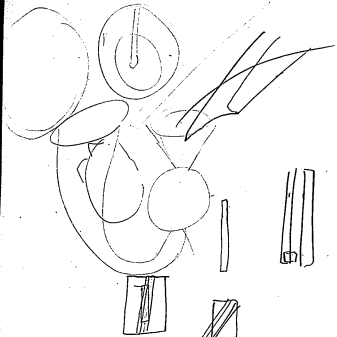
the invention. In fig
5 is shewn another
method of winding with
an even number of coils
but only [illegible]
to illustrate [illegible]
of winding [illegible]
with the form of the
brushes and [illegible]
NO 1. & 4 — wherein
[illegible] is applied to
the wire — then the wire 4
crosses around the [illegible]
[illegible] [illegible]
in the air at
at 10: hence is not used
in the position, but the

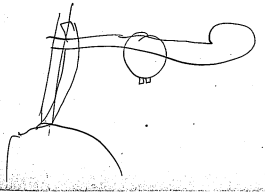
wine 14 passes over the
north pole returns via
wine 6 under the south
pole returned over the
North pole by wine 16,
returning under South
pole by wine 8. Then over
North pole by wine 3.
returning under S pole by
wine 11. When ash is counted
to 6 Cock 4 all the wine
of the wine is not used
if the brushes are at
6 Cock 2, 4, 5. then the
wine 6 over the north pole
passes around the other
3 times ending - 2 turns
at 10 is not used -

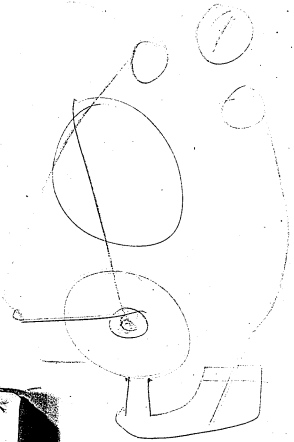
but the wire 16 passes over 15
north pale returning under S
pale by wire 8, thence over N
pale by wire 3, returning
under S pale by wire 11,
thence over N pale by 5
returning under S pale
by 13, which makes Connection
~~to~~ ~~block~~ Connection
to block 5 the wire 7
which connects to the
block also passes twice
around the cylinder 7 & 15
in the same direction
so no matter what
position the brushes may
be when they open or close
See page 173

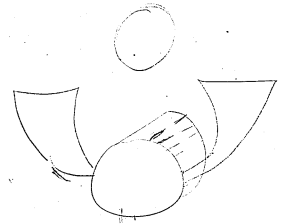






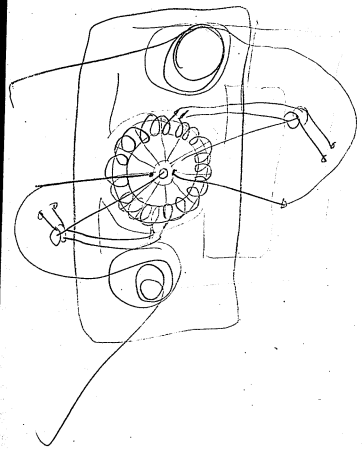






March 1 1879

Chas Blatchley



apart 1/2 of the area is
always considered proper
for reckoning the Circuit within
the a Chain is thrown out a
Circuit. I will mention
than an extra Chain may
be inserted in the middle
& divided in five parts on
part of which the area
not may be Considered of the
other part even no 10 is
this will to some Extent
prevent map errors.

Referring to fig 1

x . n are the Communicating springs secured to a disc q which rotates with the shaft =

b . & . a are insulated Collars. The collar b is connected to the brush n. while the other brush m is connected to one End of the fixed spring within the shell the other End of the fixed spring

is connected to the brush
A by a wire passing through
a groove in the shaft
hence the wire upon the
~~slit~~ interior is connected
in the same manner
with the positive magnet
+ the ~~current~~ resultant
Current is taken from
the machine by the
brushes d. e. resp.
in the coil 6, 4, 6,

I will mention that the field magnet inside stand while the outer shell be made to rotate.

~~In the case of~~ I also show the iron armature core by stepped pulley ring & head rigid & the ~~brass~~ wire wound around this iron shell & the wire connected to the commutator by leads to rotate

In practice it shall
put at fan upon one end
of the shaft to create
a draught of air
through the machine
to carry away any heat
which may be generated
when the machine is made
to exceed its normal
capacity, ~~with~~ it
but this will not be
necessary under ordinary
conditions as the Rudd
Magnet unlike similar
magnets used in this
class of machine

where several Layers
of wire is wound one over
the other & there prevent
dissipation of heat,
has only one Layer of
wire hence all heat is
in Contact with the
air & no loss of heat
in Chest ~~any heat~~ accumulation
of heat is impossible.

Claims

~~The Coil of~~ The Coil
herein described consisting
a cylindrical magnet
e.g. Bundle of iron wires
the Entire Surface being

as described.

2nd The shell shown connected of ~~with~~ an odd number of Coils and connected to an odd number of Commutator portions & Coils all arranged connected & operated Jacobs Coils [illegible] each.

3rd The method of [illegible] the shell as shown & described in ~~Specification~~ Fig 5

4- In Combination with ~~the foregoing~~ a rotating

fuel drawn quite such as described of the shell of fig 4 or 5 and the outer man cylinder for the purposes set forth,

5th = The use of intervening fabric to form the packing upon which the one of the Cominutators is carried

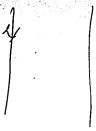
T. A. Edison
Assignor to
Menlo Park, N.J.
1879

Platinum wire made incandescent and a slight pull put on. Streaches 1/4 inch on a 4 inch piece of .005 inch. Under the Microscope innumerable deep cracks are seen =

Platinum .005 wire 4 inches long pulled through the fingers gently for 20 time cold elongates 1/16 of an inch. =

Streaching Cold does not show cracks breaks off [illegible] thin

Copper wire healed red & kept streached. shows these cracks under Microscope. This seems to prove that the phenomena of annealing with consequent pliability is due chiefly to Cracks.



2.6
5.4
60

6 in
3.14
6
12 18.84
1.57

How do you get that now ?

now is the winter

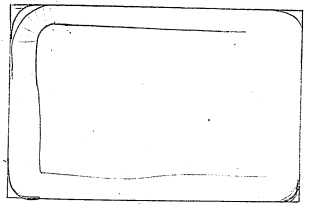
How do you get

I think that I can write very poorly now now is the winter

How do you get that

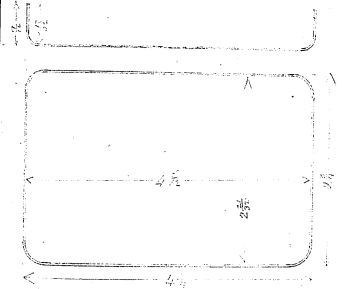
How

Pages 194 to 233. "Telephone Notes & Sketches, largely on Electro-Motograph Receiver." (Unimportant)



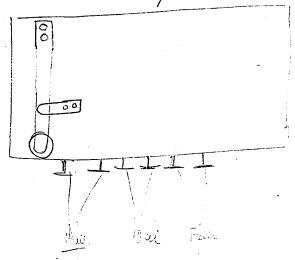
196

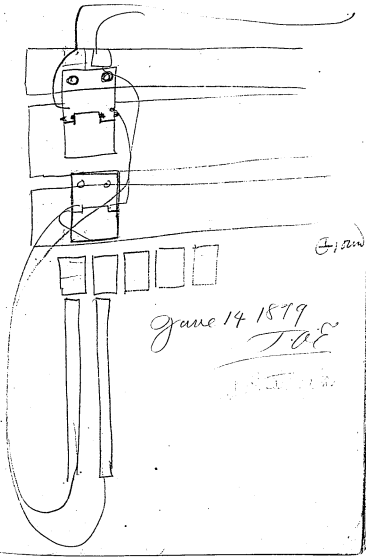
Rubber Mat for Telephone



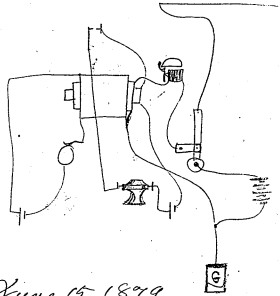
6 layers of No 30 wire on top of induction coil

Take control off arm and flexible lead fitting put on 2 more terminals



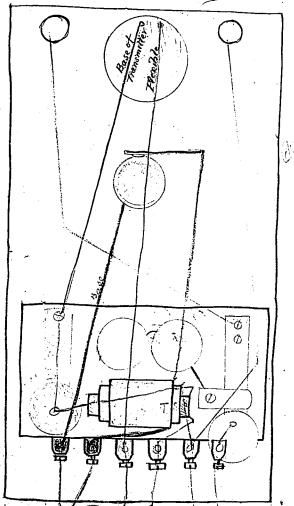


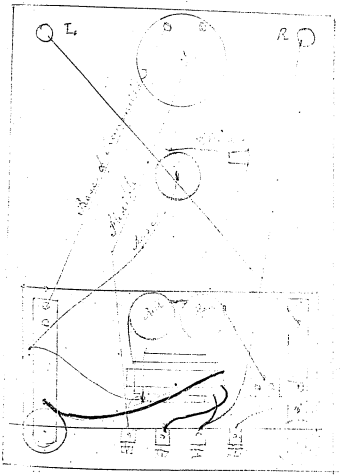
June 14 1879
TAE

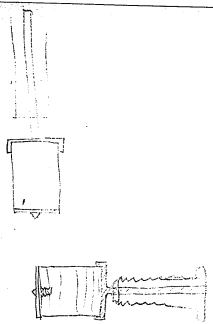


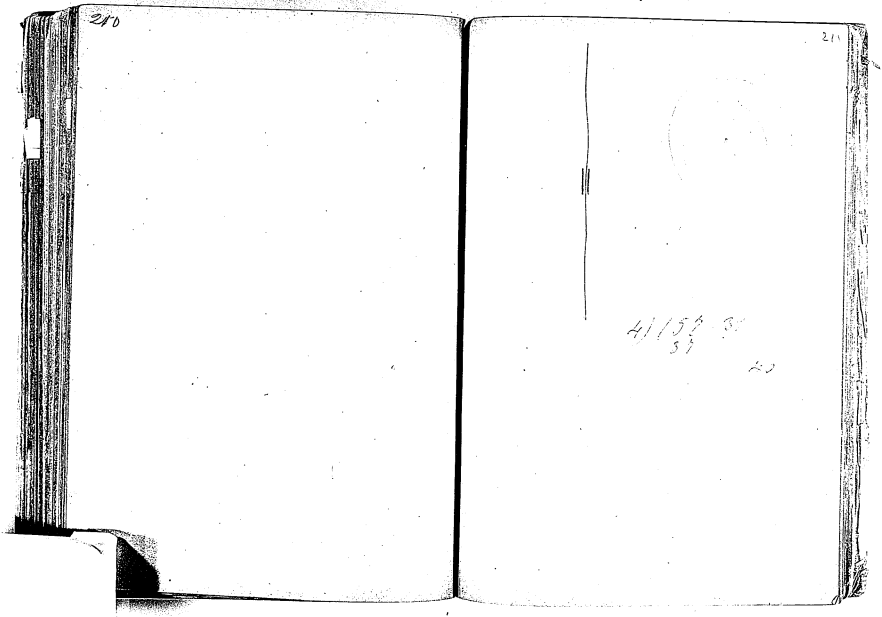
June 15 1899
T A E

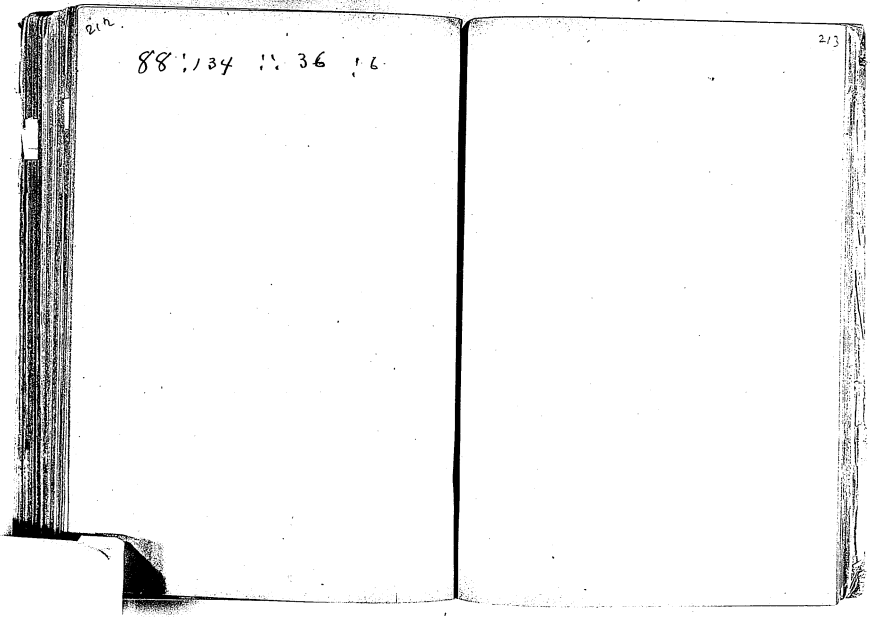
June 15 1899 T A E




L
R

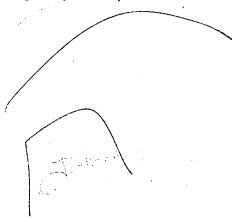


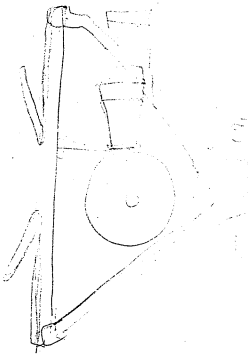



212.
88 ; 134 :: 36 : 16
213

Bourseul's telephone

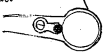
July 4th 1879





Edison Telephone

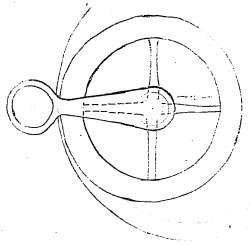
July 4 1879
Chas. A. Tainter

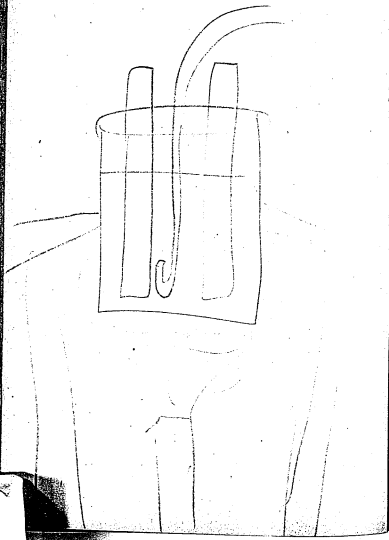


Edisons Telephone

July 4th 1879 221

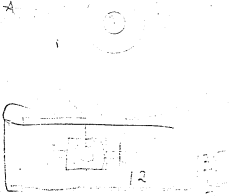
Diagrammatical

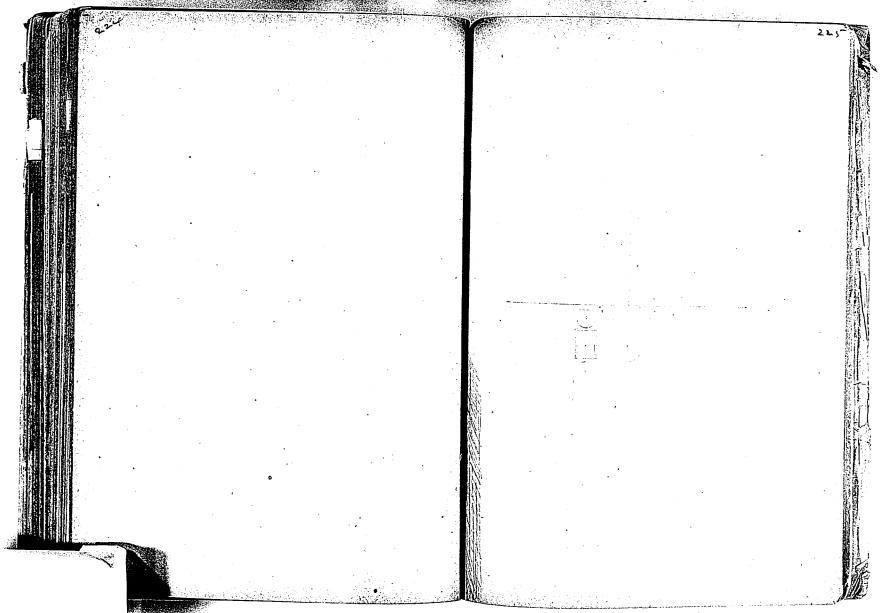


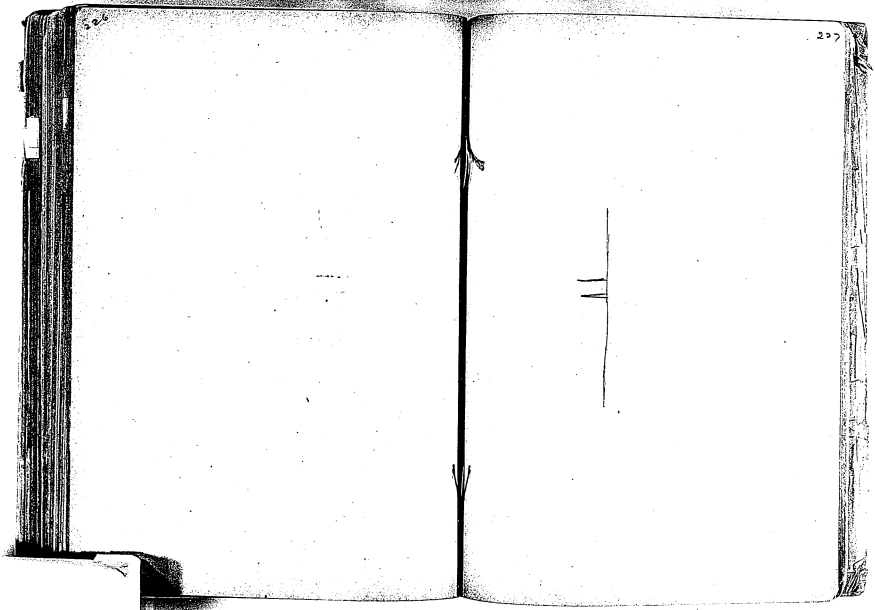


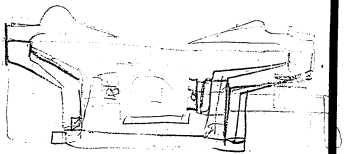
Edisons telephone July 5th 1879 225
Chas Batchelor

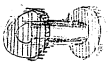
Alter the model made by Mr. myself 7th,
to this

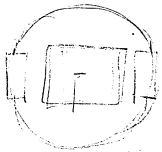






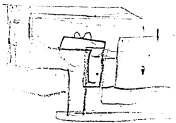




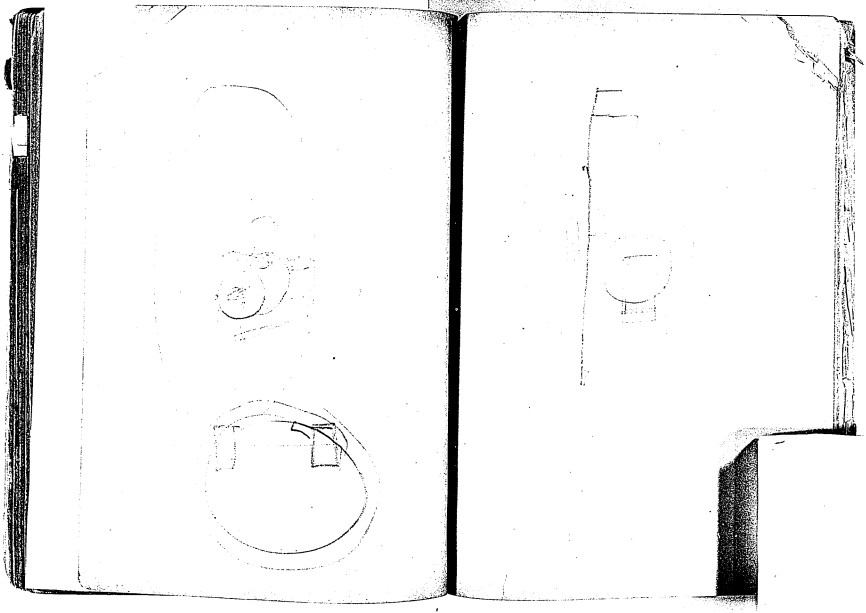


32, 72/7 = 504.

1·19, 50/7 = 35-2



25



$\frac{1}{2}$ $\frac{1}{16}$

.125
.0625

.0625
3
.1875
.125
.19375
1193
.096

$\frac{1}{16}$
$\frac{1}{2}$
$\frac{3}{16}$
.19375

06

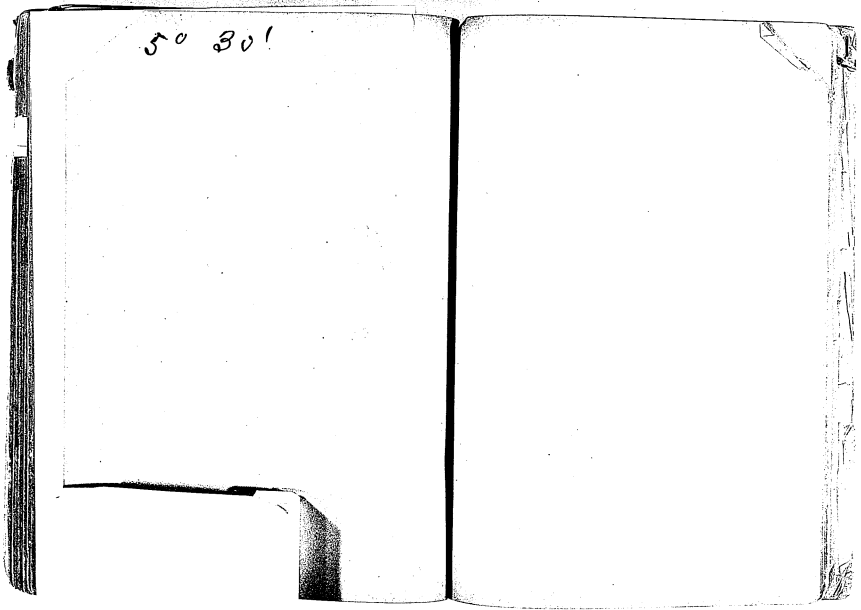
.0625 2.7959
.0625 2.7959
3.14 .4969
.5 1.6990
3.7877

.00613
800
4.90400 cu inches

16
16
96
16

1.223 16 1.2041
16 3
16 3.6123

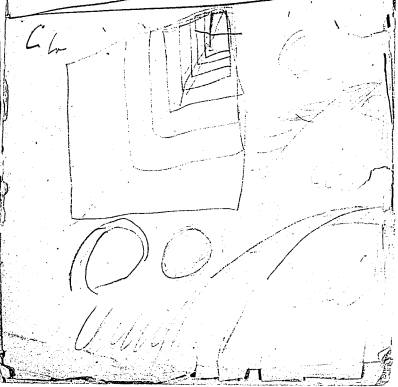
4096


50 301

$C_{total} : C_{branch} :: \frac{1}{2}$

Dec 31 1899

C_{br}



$C_1 : C_1 :: R : \frac{R_1 + R_2}{R_1 R_2}$

$C_y : C_2 :: R_2 : \frac{R_2 + R_3}{R_2 R_3}$

$C_1 = \frac{R_2}{\frac{C_y}{R_2 + R_3}}$

$= \frac{R_2^2 R_3}{R_2 + R_3} \cdot \frac{1}{C_y}$

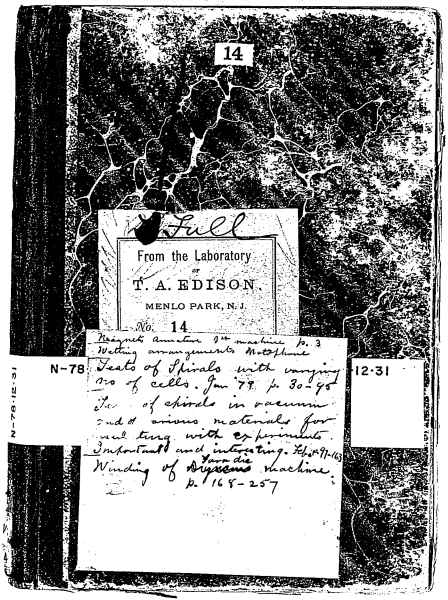
$C_y = \frac{R_2^2 R_3}{R_2 + R_3} C_1$

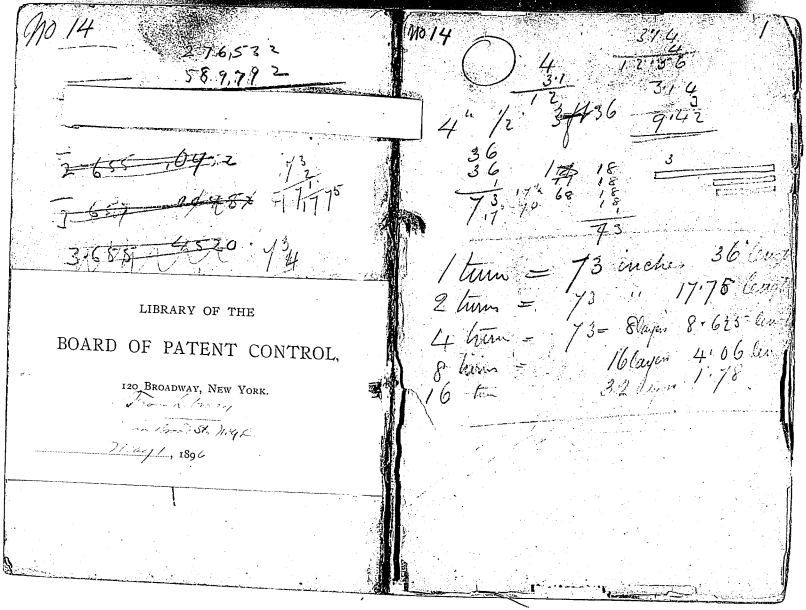
Please shrink on scanner
Obstacle left

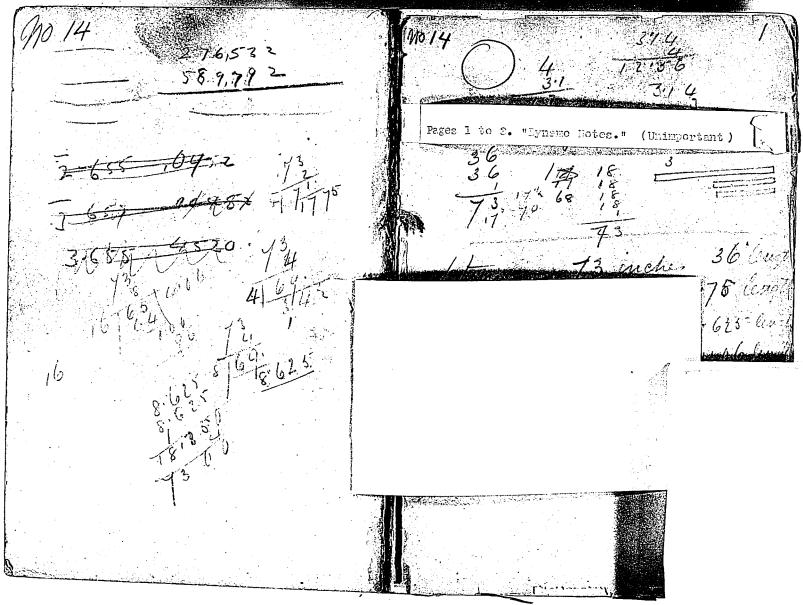
Menlo Park Notebook #14 [N-78-12-31]

This notebook covers the period December 1878-February 1879. Most of the entries are by Edison, Charles Batchelor, and Francis Upton. A few entries are by Charles P. Edison and John Kruesi. Many entries are signed by Edison. Almost all of the material relates to experiments on electric lighting. There are notes and calculations about lamp and filament tests, including a numbered series cross-referenced to other notebooks; and notes, drawings, and calculations about generators, some similarly cross-referenced. There are also notes and drawings of the new receiver for the telephone. The book contains 288 numbered pages.

Blank pages not filmed: 4-5, 236-237, 280-285.


14
Full
From the Laboratory
of
T. A. EDISON.
MENLO PARK, N. J.
No. 14.
Magnet armature & winding arrangements p. 3
Tests of Spirals with varying no of cells. Jan 77. p. 30-45
Use of spirals in vacuum and various materials for making with experiments. Important and interesting. Feb. 77-143
Winding of Dynamo machine. p. 168-257
N-78
12-31
N-78-12-31


No 14
LIBRARY OF THE
BOARD OF PATENT CONTROL,
120 BROADWAY, NEW YORK.
No 14
1 turn = 73 inches 36 turns
2 turns = 73 " 17.75 turns
4 turns = 73 = 8 layers 8.625 turns
8 turns = 16 layers 4.06 turns
16 turns 32 " 1.78

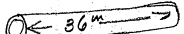

No 14
No 14
Pages 1 to 2. "Dynamo Notes." (Unimportant)

16 | 94 | 59 | 16
8 | 6 | | 9
142 | 144
59 wires | 152
x3 | x3
177 | 456
41 | 13 | 1064
430 | 11096
359 | 925

Chat Spectator Dec 1878 3

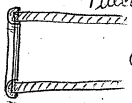
New Magneto Machine

Armature



Diameter outside 3½
inside 3

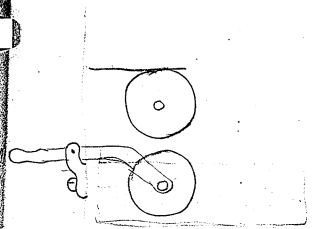
This armature has ends of Vulcanized fibre bounded by discs as not to touch the wire



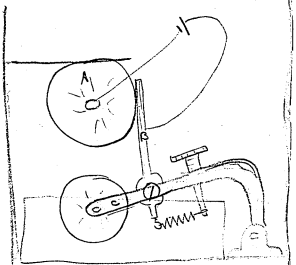
And one wire wound round it lengthwise and one end polished off so as to be used as a Commutator.

6

New Lecaister Dec 31st 1878
Chas. F. Edison



New Reciter Dec 31st 1878
Chas. L. Edison

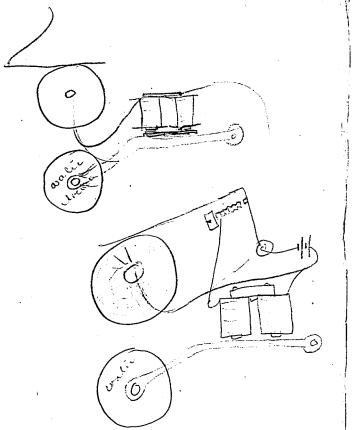


friction feed.

when button (A) is dry there is greater friction which draws up screw (B) which elevates lever (C) with moist roller

New Receiver Dec 31st 1877 //

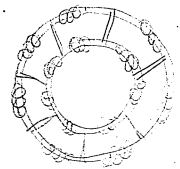
Thos. A. Edison

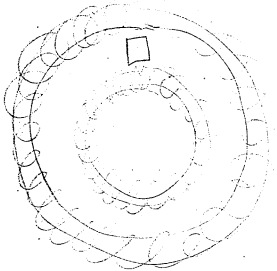


12

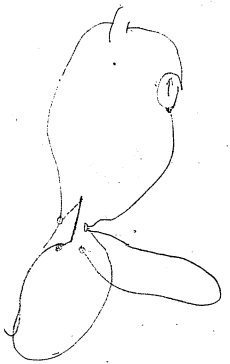
New Leaves Dec 31st 1874

Dec 31 1878





16



$R + B : B :: D : D_1$

$R D_1 + B D_1 = B D$

$B = \frac{R D_1}{D - D_1}$

$G + B + R : G + B + R_1 :: D_1 : D$

$(G+B) D + R D = (G+B) D_1 + R_1 D_1$

$G + B = \frac{R_1 D_1 - R D}{D - D_1}$

2

11

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{R_1 + R_2}{R_1 R_2}$$

$$C = \frac{\varepsilon}{R} \qquad C = \frac{\varepsilon}{\frac{R_1 + R_2}{R_1 R_2}}$$

$$= \frac{\varepsilon R_1 R_2}{R_1 + R_2}$$

$C_{total} : C_1 : C_2$ (totals) : R_2

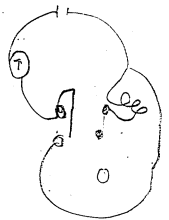
$R + R + 9$ Dec 31 1979 19

$R + R_1 + 9$ 9

$R + \frac{R_1 + R_2}{R_1 R_2}$ $R_1 = 9$

$R_2 = 9 + R_3$

$R + \frac{9 + 9 + R_3}{9(9 + R_3)}$ $\frac{9}{2}$



20

Current in one arm

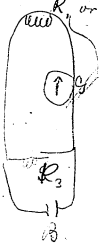
$C_1 : C_2 :: R_2 : R_1$

$C_{1\,total} : C_2 :: R_2 : R_{1\,total}$

$C_1 \quad C_2 \qquad \frac{1}{R} : \frac{1}{R_2}$

$$\frac{C}{C_2} = \frac{\frac{1}{R_1}}{\frac{1}{R_2}} = \frac{R_2}{R_1}$$

Dec 31 1898 21



$C = \frac{\mathcal{E}}{B + \mathcal{G} + R_1}$ Tick

$C = ?$

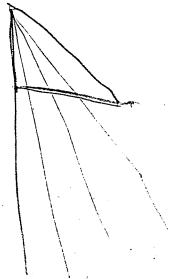
$$C_{total} = \frac{\mathcal{E}}{\frac{R_2 + R_3}{R_2 R_3} + B} = \frac{\mathcal{E} R_2 R_3}{R_2 + R_3 + B R_2 R_3}$$

$$\frac{C}{\frac{R_2^2 R_3}{R_2 + R_3}} = \frac{\mathcal{E} R_2 R_3}{R_2 + R_3 + B R_2 R_3}$$

$$C = \frac{\mathcal{E}(R_2 + R_3)}{R}$$

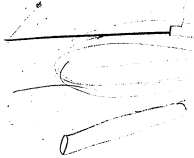
24

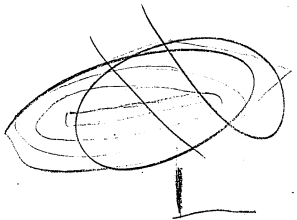
5 $\frac{9}{16}$

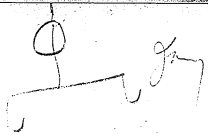


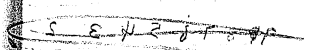
25

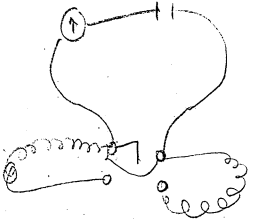
(7)



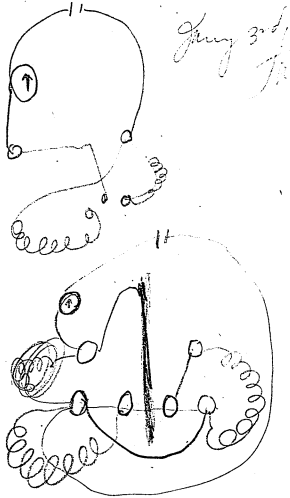








June 3rd 1879



30

1. 150 mm. ~~Pt~~ .004 wire
Iridium Pt alloy 20%
Spool No ~~#~~ 1
The wire stretched between
the two small wires

~~6.39~~

Cold 6.39 Ohms

Called. 7.15 on the steps
Without a shunt

2. Pt. 9 ad. the same as
No. 1. D= 40 .0392
R = 6.39
One cell carbon
same resistance cold
deflection 4° on steps
Called with shunt of [illegible]

3. Pt. 9ad same No. 1
2 cells Carbon
7.80 Ohms
6° deflection with
shunt as in 2 & 2
.0860
2.19 times.

324

4 Same as No 1

3 cells carbon

Bradley with shunt as in No. 2

8.1 Ohms

8°

9.147
9.147
.908
19202

log 0.159 — $\bar{1}.202$ — .159

$\bar{2}.593$

4.06 — .1609

Same as No. 4. Throw 3rd 5/33

4 cells carbon

8.8 Ohms

10° deflection Mr. B. thinks that this is just on the read very faint "fundamental glimmer.

9.246
9.246
.940
19436

log. 0.273 — $\bar{1}.436$

$\bar{2}.593$

.843 — 6.97

34

6 same as No 5

5 cells

Bright red No. 1

9.8 Ohms

D = 11°

9.288
9.288
.991
19 567
log 0.369 1.567
2 593
.974 9.42

1.567
1.436
.131 1.35
2.04

same as 6

6 cells

Bright red in diffused daylight, white covered

10.2 Ohms

D = 12° 30'

35

7

~~9.255~~
~~9.255~~
9.345
9.345
1.008
19 698

log 0.499 1.698
2.593
1.105
12.7

1.698
1.436
.262
1.85

1.698
1.567
.131
1.35

1.698
1.436
.262

36

same no 7

7 cells

Yellow red or orange look like $\frac{1}{32}$ in diameter

$\mathcal{D} = 13° 30'$ distance 2 ft.

$R =$ ~~[illegible]~~ Ohms

11.1 Ohms

	9.380	
	9.380	
	1.045	
	19.805	
log .639	$\bar{1}$.805	
	$\bar{2}$.593	
	1.212	16.2
	$\bar{1}$.805	
	$\bar{1}$.436	2.36
	369	
	238	1.73

same no 8

37

8 cells

Yellow and beginning of light "small" about $\frac{1}{6}$ light "looks at distance of two feet to be $\frac{1}{16}$ of inch thick. Lags $\frac{3}{8}$ in.

$\mathcal{D} = 14° 30'$

$R = 11.1$

	9.412	
	9.412	
	1.045	
	19.869	
log 0.740	$\bar{1}$.869	
	$\bar{2}$.593	
	1.276	18.9
	.433	2.71
	.302	2.0

38

9 cells

Quite white.

Appears a shade more than 1/10 at 2 feet

D = 15.0

R = 11.2

9,428
9,428
1,086
.875 7 942

1.349 22.3

.506 3.21

.375 2.38

39

10 cells

a good bright light, wire appeared to radiate a little, appeared no larger

D = 16°

R = 12.6

9,457
9,457
1,100
20,014

~~.875~~ 0,014

1,030 1.421 26.5

.578 3.79

.447 2.8

9.2 40

11 cells

with shade of yellow

White light the cusp seemed covered with fine lines

D = 17° 30'

R = 12.96

9,498
9,498
11,110

Log 1.28	.106		
	2.593		32.7
	1.513		
	T 1078		
	.670		4.68
	.106		
	1.567		3.48
	.539		

41 13

January 3rd 1919

12 cells

~~Brilliant~~ Full white

D = ~~15~~ 18° 30'

R = 13.26

9,524
9,524
1,122

1.47	.168		
	2.593		37.8
	1.575		
	.168		
	T 436		5.4
	.732		
	.168		
	1.567		3.98
	.601		

13 cells

Brilliant white

λ = 19° 30'

R = 13.56

9.549
9.549
1.132

1.70 .230
2.593
Cold 1.637

.230
1.436
.794

.230
1.567
.663

43.4
~~43.4~~
~~43.4~~
6.22
4.61

14 cells

Intense white as far as
washed

236
2.593
1.643 44.

λ = 19° 30'

R = 13.86

9.549
9.549
1.138

1.72 .236
Just Red 1.436
log 6.31 .800

Red .236
log 4.67 = 1.567
.669

No. 2 $D = 4°$

$R = 6.39$

C° M.

8.8xxx
2.xxx
.805
18.593
2.593 .0392

No. 3 $D = 6°$

$R = 7.8$

9,021
9,021
.592
18 934 .0860
2.934
2.593
.341 2.19

January 3rd 1919 [illegible]

when a 150 mm. bar of [illegible] is brought to maximum & permanent elongation ½ a mm due probably to being alternately [illegible]

If when measurements [illegible] the readings straight & regular & elongation [illegible] an initial vibration not easily found —

Measurements — [illegible] is an advantage [illegible] to have the light & will often a moment of quiet commence (a vibration of a tuned string) [illegible] a vibration of ⅛ of an inch upon a unit, when it ought by this effort [illegible]

The effect of this vibration is also to cool the iron producing Carbon below a blue light appears in the [illegible] of the unbent part

of vibration. January 3 1879

By the wire is bent 209 209 - 209
& the Current put on & off
with a rapid movement — the 209
209 jumps apart & remains suddenly
Coil is perfectly represented

At a distance of 15 feet the
Electromagnet will lookate by
3/16 of an inch above the

16 4/4 cells Carbon makes 5 30 ohms
.004 Just faint red. Stitches in the open air.

D = 10° 30′ with shunt
R = 30.86 ohms

The same as 16 with Calloid 4/17 cold.

Young 3′ 1873
J.Y.

R = 20.46
D = 22° 30′ on no 3. wire

1810 .000 Rh. Iridium 150 Mm

Rhod ≅ 2

Cold
1 colloid R = 6 ohms

19 1 cell Carbon

D = 4.

~~R = 6.7 ohms~~

R = 6.1

0.030

8,844
8,844
.826
18.514

8,844
8,844
.784
18.476
2.476

2 cells 2057

D = ~~5.745~~ 6°45' ~~9.000~~ ~~9.000~~

R = 6.7

9.073
9.073
.826
18972
2.972
2.476
.496

~~.826~~

0.0938 Gray? 1879 Tait

3.1

2023 cells

D = 9° 30'

R = 7.3 ohms

0.204

8.6

9.223
9.223
.863
19.309
1.309
2.476
.933

4 cells slightly red

-220-

D = 11°

R = 7.9

0.297

9.9

9.288
9.288
.597
19.173
1.173
2.476
.997

January 5 '23

TJR

2354

5 cells dull red

$\Delta = 13°$

$R = 8,5$

9,363
9,362
929
19.655

0.452

1,655

18,1

1,179

1,53

,182

6 cells red orange

$\Delta = 14°$

~~$R = 8,9$~~

$R = 8,731$

9.396
9.396
929
,947
19.733

0.541

T 733

18,1

1.257

1,82

.260

1.19

.078

D-24

2.5.56

7 cells Orange yellow
a slight wind may be seen by
squinting the eyes

D = 1.5"
R = 9.2

9.428
9.428
.963
19.819
1.819
2.476 22.2
0.660
1.343

1.473
.346 2.2.3

7.655 1.64
.164

8 cells Yellow
squinting little orange
D = 16 -
R = 9.16 Ohm

9.457
9.457
.982
19.896
1.896

.788

1.896
2.476 26.3
1.420

1.896
1.473 2.64
.423

1.896
1.655 1.74
.241

9 cells bright yellow
whitish yellow

Δ = 17° 30′
R = 10

9.498
9.498
1.
19 996
1.996

0.991

1.996
2.476 33.1
1.520

1.996
1.473 3,31
323

1.996
1.655 2.21
344

10 cells dull white
yellowish white
white yellow

D = 17° 30′
R = 10.3 Ohms

9.498
9.498
1.012
20 008

1.02
1.008
2.476 34.1
1.532

.008
1.473 3.43
.535

.008
1.655 2.26
.353

2960

11 cells both the same as candle E118

D = 19.

R = 10.5

9.536
9.536
1.021
20.093

1.24

.093

.093
2.474
1.617

41.4

.093
1.473
.620

4.17

.093
1.655
.438

2.74

12. A little yellower than candle G
Whiter than candle E 9 13.30

D = 19° 30'

R = 10.7

9.549
9.549
1.019
29.117
25.
D.117

1.34

.127
2.479
1.648

44.5

.127
1.473
.654

4.53

.127
1.655
.472

2.97

3/13/27

3 cells

a little yellower than candle 11 ohms distance

Bright White 5 ohms

N = 20'30'

R = 11 ohms

9572
9572
11041
20185

1.53

.185
2.476
1.709

51.2

.185
1.473
.712

5.16

.185
1.655
.530

3.39

14 cells

Filament of 15 cp 220 V

Brilliant White 5 ohms distance

The same as candle 11 distance

D = .210

K = ~~11.5~~ .1

placed side by side and it seemed whiter and 8 times easy by eye than Fuchs

11.5 Wire melted at 140 amps

9.558 in bench.
9.558
1.060
20226

.228
1.473 m.22
.755 day

5.69 times

.228
2.476
1.752

1.691

56.5

1.~~23~~ 1.6 ~~X~~
5.64

.228
1.655 m.23
.573

3.75 times

64 See sheet no 3

Pt wire .004 150 mm

1 cell D = 5.0

R = 4 ohms

8.9419
8.9419
.6020
9.5439
-1.4858
E. 8581

6.356

2 cells D = 8° 30'

R = 4.9

9.1744
9.1744
.6932
19.0420
-1.0396
-2.4858
E. 5532

0.12

3.56

3 cells D = 11°

R = 5.7

9.2456
9.2456
.7558
18.7470
-1.3330
-2.4858
E. 8472

.215

7.03

65

4 66 cells D = 13° ~~Dull red~~
R = 6.5

Dull red bells shown first column on No. 1 Test Sheets

9.3633
9.3633
.8129
19.5395
1.5395
2.4858
1.0537

.3461

11.3

5 cells Red

D = 14°
R = 7.2

9.3167
9.3167
.8129
19.4463
1.5395
2.4858
1.4942

.447

1.416

1.29

Jany 5 1879

67

6 cells Yellowish orange

$\Theta = 15^{\circ}\,30'$

$R = 7.9$

8.607

19.8

1.65

1.35

9.4429
9.4429
6976
1.9176 34

$\bar{1}.7824$
2.4852
1.2976

$\bar{1}.7824$
$\bar{1}.5395$
.2429

$\bar{1}.7824$
$\bar{1}.6501$
.1327

7 cells Yellow

$\Theta = 15^{\circ}\,30'$

$R = 8.3$

0.1638

20.8

1.84

1.42

[illegible]

[illegible]

[illegible]

70

8 cells Light bright Yellow

D = 17° 20'
R = 8.701

.869

28.3

2.51

1.94

9.47587
9.4987
.9415
9.93839
1.93859
2 .45858
1.45721
1.93859
2 .53295
.3994
1.93859
1 .65147
.2858

Whitish Yellow

9 cells

D = 18° 30'
R = 9.

1,101

33.1

2.02

2.26

9.52445
9.
.1961
20 .30581
08 .30581
2.49958
1.51983
.30581
1.53395
.4656
.30581
1.03507
.3544

Jany 5th 1874
TAE

10 cell Yellowknife White

D = 19° 2.01

R = 9.7

	9.5491
	9.5[illegible]11
	.9637
	29.0619
1.15	
	.0619
	-2.4858
37.7	1.5761
	.0619
	-1.5295
3.39	.5224
	.0619
	-1.6507
2.58	.4112

11 cells White

20° 30

R = 9.[illegible]

	9.5727
	9.5727
	.0777
	29.1231
1.328	
	.1231
	-2.4858
43.4	1.6373
	.1231
	-1.5395
3.83	.5836
	.1231
	-1.6507
2.97	.4724

172 cells Brought White

D = 21°
R = 9.9

9.58841
9.18441
.9956
2.01638

1.452

.1638
-2.45558
1.67780

47.6

-1.6378
-1.52398
.62433

4.22

1.638
1.6378
.51131

3.26

13 Brilliant white 75

D = 21° 30
R = 10.5

9.1958
1.0212
20.2217

1.643

-.2217
-3.48558
1.7359

54.4

-.2217
-1.52398
.68322

4.81

-.2217
1.0207
.5710

3.72

Jany 8, 1895

14 cells omitted

76

150

4 in = 100

6 in

.314
.004
.001256
6
.007536

.314
.004
.001256
6
.007536

.075) 1.000 (13
75
150

78 Iron lamps and 6 cells
D = [illegible] = 19°

R = .5 ohms both
Cold 1.2 ohms
9.5 369 The same ohms
9.5 369 as on Jan 14.
.69 69
19.7727
7.7727

.592

.2217
No. 3 .7727
.4490

White [illegible] wire No. 3. [illegible] gauge
[illegible] 2.8 more heat than red
2c. lamps with 1 in. surface

Jan 15.
Question how many lamps can be made to give 15 candles when nine gave

Three Iron lamps
all the cells of battery = 14
65° on No. 3 11.6 Ohms

3 2c. Lamps
D = 19° with shunt
2 2c. lamps. Thin surface
D = 21
R = 11. .02

14
.16
16.8

80

5°

8.9419
8.9419
0.7853
~~19.6691~~
~~1.6691~~
18.6491
2.5691

.46

6°

9.0216
9.0216
1.7853
19.8285
1.8285

.67

46) 346 (7.
322
240

67) 346 (5
335
11

2 ohm + B

16° = 0 + 10 = 17°

8° 30' + 1 = 9° 30'

$$C = \frac{\mathcal{E}}{R + B}$$

$$C_1 = \frac{\mathcal{E}}{R_1 + B}$$

$$C(R + B) = C_1(R_1 + R)$$

$$\frac{C_1 R_1 - C R}{C - C_1} = B$$

17 = C

9.5 = C_1

2 = R

4 = R_1

17 − 9.5 = 7.5

$$\frac{38 - 28.4}{7.5} = \frac{4}{7.5} = .53$$

.22 Ohm = R

1 Cell C, 2 Ohms in 42.5° = .932

C, R, 4 Ohms in 26° = .487

.487 × 4 = 1.948

.932 − 1.948 = −1.016

.932 × .487 = .454

.932 + .487 = 1.419

4.5 × 4 = 18.0

17 / 7.5 = 2.4

7.5) 4.00 (.53
    375
    .250

N_a R

82^0

.4 70^0 990

.4

396.0

$C = \frac{\epsilon}{R}$

$C_1 = \frac{\epsilon}{R+R}$

$CB = C_1B + C_1R$

$B = \frac{C_1 R}{C - C_1}$

tan 82°. 990

tan 70° .1939

.051

.396

Platinum wire .004

150 m m

14 ells Dull Red $6\frac{1}{4}^0$

Resistance 28 ohms

Reflect in Good as

11 Bent Ke[illegible]

Shaft bent down
Deflection 12°

Deflect 12

$W = \mathcal{E} q \qquad \mathcal{E} = C R$

$q = C t$

$W = C^2 R t = H$

$H = C^2 (\rho + r + \ell)$

$C = \dfrac{\mathcal{E}}{\rho + r + \ell}$

$H = \dfrac{\mathcal{E}^2}{\rho + r + \ell}$

Seven lamps in multiple are each 22 defect estimated to have life of 20 Ohms in H. 5 Ohms in 1

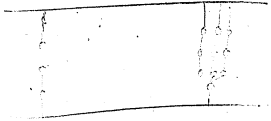
4 in H and in multiple 4 0

January 12 '07

90

1.243

8-51 P.M



75
2

150	0.176091
265	0.371454
205	0.271454
	.919997

524

3 lamps in multiples of
... batting rod lots

D = 51° 1.27

Rh lamps

2 - 64° 2.05

60

1.27 2.05

5/2 = 1.66
1.27
1.27

267

92

$\frac{1}{1.27}$ 2

2500

1 Ohm at 6.2°

2438

256

256) 2438 (9.5

2304

1346

1.6

3

4.8

1.27 2.05

1.27) 2.05 (1.6

1.27

780

762

18

$C = \frac{\varepsilon}{R}$

$1.27 = \frac{\varepsilon}{1.57}$ $1.57 = \frac{\varepsilon}{1.57}$

$C = \frac{\varepsilon}{1.57}$ Jan

$\frac{1}{1.57}$ $\frac{1}{1.27}$

1.27 1.57

1.27

$\frac{1.57 \times 1.57}{1.27 \times 1.27}$

$1.27 = \frac{1}{R^2}$ $1.57 = \frac{1}{R}$

$R = \frac{1}{1.27}$ $R = \frac{1}{1.57}$

1.27 1.57

$\frac{50}{10}$ 5 per H.P.

10002

1.1240

3,6
2
7.2

72 | 1.1240.0 | 1560
72
404
360
440
432
80

1.1240

7.2

Janry 12 1879

24.200.
5600

Feby 6 7 8 9 10th 1879

Experiments with cones in a Vacuum -

Platinum Iridium alloy 20pc Ir =

One Mechanical pump with $\frac{1}{100}$ of an

inch vacuum = Pt-Ir wire loses weight

= $\frac{1}{10}$ of a milligramme per hour, which

is deposited upon the glass - the surface

on which this loss occurs is about

1/4 of an inch. Resistance .75 of an ohm

Cold sign wire .020 of an inch

If the platinum wire is brought to a

dull red and the vacuum made

1/10 of an inch & allowed to remain

red for 1 minute & then made

yellow and the vacuum made perfect
again then were brought gradually
up making vacuum perfect after
each increment of heat the wire may
be brought to 21 candle power (10)
1/4 of such radiating surface will
give 21 C.P. the wire grows
exceedingly bright, swelling polished
silver and under the microscope
shows no cracks, when cool
brought to incandescence and then
it shows great cracks: I think

from our experiments that the
melting point is determined greatly
by the amount of gas within the
pores of the metal which by its
expansion disrupts the metal and
makes it fuse sooner. By gradually
increasing the heat the gas
gradually comes out of the metal
without disrupting & cracking
it. Roughly speaking I think
that if the melting point of
platina in the air by sudden
bringing to incandescence

i 2000 °C than something
point unrelated to at least
room C by subjecting it
to the process of annealing
it was by heat in a muffle
3½ Candle power until that
we have an engine of 1/4
for 1/4 inch in diameter
I think all metals to unalloyed
gr in their pure or even
other metals or metallic
have a lower melting point
& cause the unequal
Expansion disrupt the

Metals crack it thus 105
allowing it to fall on
Equipment to the b[illegible]

Feb 10 1849

Experiments with Steel
Pianoforte wire in vacuum
about .020 wire - 1/4 inch
radiating surface

We cooled one with cheese
water & dried [illegible]
Vacuum. Some of the elements
were brought to ~~boil~~
impure when to heat -
there was large amount

al: pallen oxide that was
from one turn to about —
cross connected; the evaporation
of the chalk makes quite arbonic
acid probably prevented the
oxidation = we have not tried
previously that pieces could
may be brought [illegible]
to give cobalt mixed with
but the oxide fumes has a
much lower melting point
than the steel thus if
Rockell W? excludes air the
gases have a 1.000.000 of

an atmosphere of nitrogen
& the iron wire [illegible]
we [illegible] brought to [illegible]
most dazzling [illegible]
we observed [illegible]
nothing & I do not think
there was any [illegible]

We now put in a spiral (
with lime in N_2O & drive
very little oxide formed but it
united steadily causing us
before the spiral = the lime
does not stink well but

Cakes off = of metals when the
melted & flowed where lime upon
it. Beautiful scales of
Violet & gold Calx probably
a Compound of Ammoniacal

We now put into a plain steel
spoon a Cake of each, & melted
out so turns more into a Cake
in Contact - & we continue
to raise the heat gradually
in 2 minutes we observed
a full white in a stinging
so high as to melt
parts somewhat

we now put in another sheet of opinel
with its convolutions further apart
to procure a greater variation in heat
at parts of the opinel - brought
it to steam which when it melted
in one spot showing a flaw there -
stained leaves of gold in all
parts before melting and there
been no flaw -
Procured
tried another piece brought
it up very gradually it was
coated with black or blue
Oxide with 2 coats
when it melted it went in
all parts at once

when change to say the
oxide vaporized on the glass
& left the whole of the
spiral which was incandescent
as bright as Silver.
I found that the brightness
was was entirely dependent
& could be hardened when
a part which was only dull
red was hardened by water
until it was as bright as
glass ——
We put Asbestos wire in
Atmosphere of Hydrogen.

if required a very much greater
Current to raise it to redness
and it melted at a much lower
white heat showing apparently
that the Hydrogen had more
influence on the [illegible] of
tion upon the metal
metal process
point as the iron itself
a vacuum yet the [illegible]
twice the light.
Perhaps there is
quantity of
in the atmo-
~~atmosphere~~ free. The

of the hypothetical ether -
thus accounting for the
diminished intensity of
the platinum in air as against
the vacuum; of course taking
into consideration the
gain due to crossing of
Convection Currents -

Put in new Spiral brought
to yellow white at 4.35-
PM on gramme machine -
added current 4.50 brought
to incandescence fused 4.52

Magnesium wire was brought to a dull red & fused melting on a vacuum hence the melting point as given in the books

(1) .447. Fahr or 230 C must be wrong or Draper is wrong in attributing 900 to a dull red =

We now put a Wrought iron spiral in and brought to yellow white and letting it gradually fall to dull red in 25 minutes

owing to polarization of the battery - ~~Walter~~ go to Rumpus ~~to~~ to take battery off at 6.55. We keeping up vacuum - We brought it at 7.20. to a dozzling white by Gramme but in 1 minute it melted because we tried to bring it too high.

Feb. 10

Iron wire .020 in. in diam
wound in the coils
separated .060 in. The ~~heating~~
current was put on gradually
and an aside noticed before
red heat was reached. Taken out
and polished to see if the oxydation
could have arisen from the O in the iron
again freshly oxydized.

"The color of the flame
when the iron melted was
a strong violet" E
Line B. Fluint violet H.
It was white and scintillated
some moments before melting.
The Gramme machine was
used.

179

The wire when taken apart after furnace was found to have a very high polish

No. 2 Iron W Feby 10 '94
.020 in in diam
6 1/16 in length 12 turns
.060 ∠ separated on a mandrel

Filled with H pumped out
//////// 10 times
Immediately with less than
2 in vacuum the battery was
put on. The wire became
black. The Gramme machine
used Violet Martin. Ultra violet
Edison. Light blue ∠ lighter than
the blue of Sulphur B. Blue
of sulphur N. or light blue

Ex To try iron wire in H
must have it coated with lime
to see if the presence of H
has any effects. There seems
to be in the O-H blow pipe
another effect than simple
heat in producing the intense
light formed.

The wire wound close
and the spaces between the
coils filled with lime. In
air of H at Atmos. pressure
with the Gramme machine
and strong current the
spiral coils red. And even
when brought to fusion

By the other day Mr. E. tried a lb. some thin wire — duction cream a ~~coil~~ coil on bottom, on the secondary. The light was quite brilliant from a very small spark. This shows the fineness of the division.

on signs of the whiteness seen on the O H blow pipe

Ex. No. 4 Feb 10 P.M. Feb 10 1879 FBS

Of iron wire

A spiral covered with titanic acid made into paste by with alcohol.

The titanium oxide ~~mixed~~ with the wire and ~~heated~~ ~~strong~~ heated to a great extent the wire. The wire melts very [illegible] tanic. Peculiar smells are received when taken off. The wire very much harder after heating and plunging in water becomes very hard but not extremely brittle.

Ex. No. 5. The wire passed through the fingers when bent at right angles and could be felt to break with short sudden jerks.

July 10 1879 gas

Ex. No. 6.

Very fine wire.

It was very light and seemed to melt at once. I have worn no ventilators.

Ex. No. 7.

Wire .014 in. Very resilient sank slowly without breaking. No ventilators.

Feb 12 1874 Tat

Ex. No. 7. Wh contains chemically pure nickel. Forged heated ~~[illegible]~~ beg H. red hot. Rolled out hot until two inches long. Then cold until about fifteen inches, and .001 in thickness and 1/8 in. in width. Ends were put as near as possible to each other and the N forced many times between them.

Ex. No. 6. 3/16 wide

Do 15m about of N cannot be melted in Bunsen and with blowpipe. Faint signs of fusion probably of the Ex No 9 wire when made less wide.

Steel wire easily melted in same flame as No. 6

Ex. No. 10. Smaller wire than No. 9 easily melts.

Ex. No. 10. Rt foil same thickness as No 5 in same frame at 1879 Feb 12 Tps

Ex. No. 11 N & Rt and in the same frame nickel as No 10 and very little difference noted in their behaviour. Rt metal slightly and a slight reduction on the N.

Ex No 12 Iron wire rolled into sheet and held in Burnham disk of metal

Ex. No. 13 Held in Hon frame from Mr Burnham Dod

not melt but ~~not~~ became very brittle and probably changed with blank oxidem. Feby 12 1897 T.M.

Ex. No. 14. The N. foil covered in a spiral on a mandril Brooks very easily at very ~~a~~ first across the foil. A spiral tried in a vacuum. 1 1/4 in Did not blacken as much before becoming ~~so~~ Could be brought to incandescence. Found with yellow light. Slight violet B. Mine spread like Mg. afterwards. Feb 11 P.M.

Ex. No. 15. A piece of Nitrum was tried in same flame as No 14 did not melt. even on the carbon Forms a bright oxide.

40

Feb. 12 1878
Mr. B. tried a globe and found glass too thin Directions for Cl Book 47 to Pg 157-159

2 p.m.
Ex. No. 16 She came as No. 15 with small spiral tire on three colors when it fevers. Retired unwell to be true.

Feb 12 1877 TAS

The following forms of affidavits was used to introduce these wire in the examination
Book 9 Page 163
See Page 117 Book 13
Page 117 Book 4 Pg 61 62, 63
for proposed form 64, 67

from forms proposed for Guessler Tube to enhance size of
Book 13 Page 114 & 121
drawn by Mr. E —

142

Memorandum of

Feb. 12, 1878.

Coating Pt with oxides by decomposition of the Nitrates by means of heat.

Ex No. 17 Nitrate of zirconium does not coat the wire at bright red nor at dull red heat. Red at little for in it

Ex. No. 18 Zircon apparently contains Mercke's Zr. very infusible. melts instantly.

Ex No. 19 Nitrate Calcium coats the wire without apparently dulling it. Under microscope cracks all over but in globules and

penny thin between the [illegible] Particles of
[illegible] very impure. Spots could
be found which the coating did not
cover. Does not even blow
with much. Wire rubbed by
finger [illegible]
The coating of
heat. At penny [illegible]
good coating [illegible]
could be obtained by
through the coating.
The idea is to [illegible]
an excess to one of the
[illegible] The value of [illegible]
found the solution.
Used the wire
current [illegible]
[illegible]. Rubbed and then a [illegible]
@ perfect coating obtained
and the wire heated by

the sides of an uncoated one
and no difference seen in the
light. Does not seem to [illegible]
the melting point of [illegible]
[illegible] Same effect at high heat
The wire appears glowing
very brilliantly and
white. Nature said [illegible]

Ex. No. 19 Ascertain if [illegible]
radiant form can be
absorbed, when the [illegible]
heat just visible, [illegible]
from [illegible] with
Give more light when at full
heat because [illegible]
require less heat [illegible]
than to incandescence
the same way heat is

Rh wire becomes polished
by the melting of the fine
[illegible] its surface
it surface [illegible]
to [illegible] the [illegible] of
the main wire will magnify
it [illegible]. Hence [illegible]
[illegible] with
[illegible]
[illegible]
[illegible]

Feby 12 1877

Ex No 20 Acetate of Ammonia does not corrode the wire at any heat.

July 12 1879 Dec

Ex. No. 21 Acetate of Lime gives a very fine deposit of wire seemingly continuous under the most ~~[illegible]~~ ; I used ~~[illegible]~~ with much success for ~~[illegible]~~ to be used also. Lime ~~[illegible]~~ combine with the Ox. Magnesia ~~[illegible]~~ of course.

Ex. No. 22. N seems to have no effect other than the air when Pt. Spiral is heated in it and also in vacuum

~~Ex. No. 23.~~

Ex. No. 23. Tried Alcohol vapor could see no change

Ex. No. 24 filled globe with tobacco smoke & watch the air connection.

Ex. No. 25 Put a piece of paper in contact with the spiral so that it would burn [illegible] good connection

Ex. No. 26 Ammonia and Hcl tried with litmus paper and needle and put in the mix got good result.

Ex. No. 27 Spiral coated with
Acetate of magnesia in vacuum
Current put on at 3.30 P.M.
Very brilliant incandescence
Vacuum does not [illegible]
after about an hours running
when it ceased to shine. Spiral
left in open air.

The tip of the glass [illegible]
and the ends coated [illegible]
with a light precipitate after
being ~~the~~ in the air for some
time. No ~~[illegible]~~ change [illegible]
turned to be [illegible]

[illegible]
[illegible]
[illegible]

Spiral covered with rust

Ex. No. 28 8-30 P.M. Same spiral 137

12 1879 Feb

White 10-3

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

In the air for 24 hours

A thin black deposit noticed

whilst the platinum remained bright

so that none was [illegible]

directly behind the wire.

The wire was [illegible]

inside of the [illegible]

as the deposit was very much

less it is hoped [illegible]

pletely covering [illegible]

be [illegible]

Fct. 131878

Ex No. 28 The coating membrane
the microscope
organisms
[illegible]

Ex. No. 29. [illegible]
and no growth

Ex. No. 30. [illegible]
distilled water
Lime, magnesia,

Ex. No. 31 Nitrate of [illegible]
and distilled water

32 Nitbiuna melts [illegible]
attacks it feebly.

33 Pelam Grind and a good
early Potatoe

Onion Ng. Globe

Nitrochloride of tin

Sticks

Confined to bed

through a bath

Effects of Strontia Failure

Chloride of magnesium

Must be

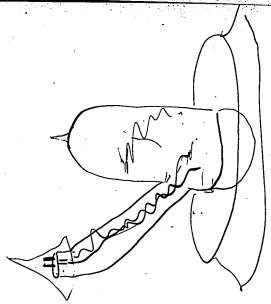
injectible

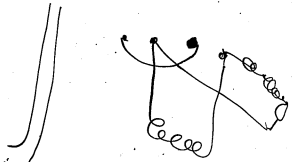
Carnelian Magnesia does not
alter when [illegible]
Good covering when the [illegible]
white heat. When continued at
white heat in the [illegible]
Turning to crystals.
Calcium combines.
Value and use of magnesia in
the various kinds of [illegible]
off [illegible]
[illegible]
Ex. No. 34 Iron by H and the
temper [illegible]

Ex. No. 35 asbestos mixed
with magnesia [illegible]
mix.

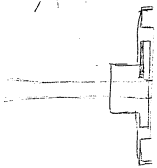
Ex. No. 36 Feby 13 1879

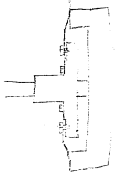
The Edison dynamo machine



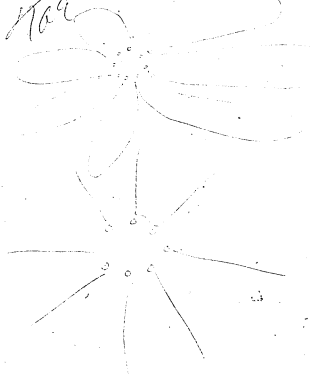


Feb. 14, 1879.
No 82

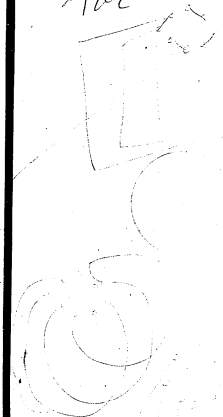




Feb 14 1879
TAE



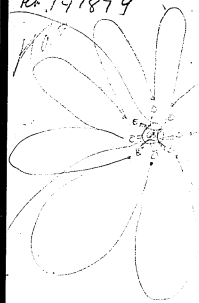
Feb. 14 1879
TAE



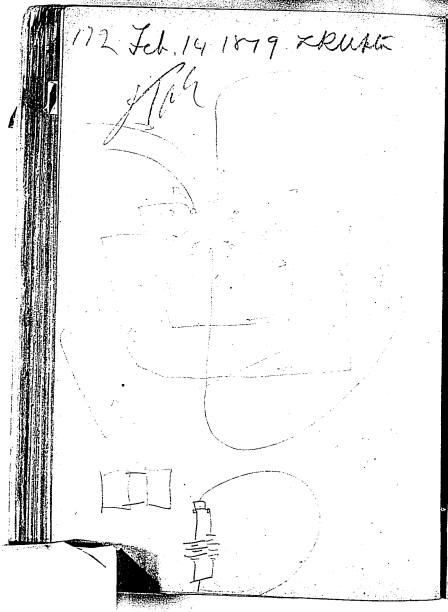
17 Feb 14 1879.

Feb. 14 1879

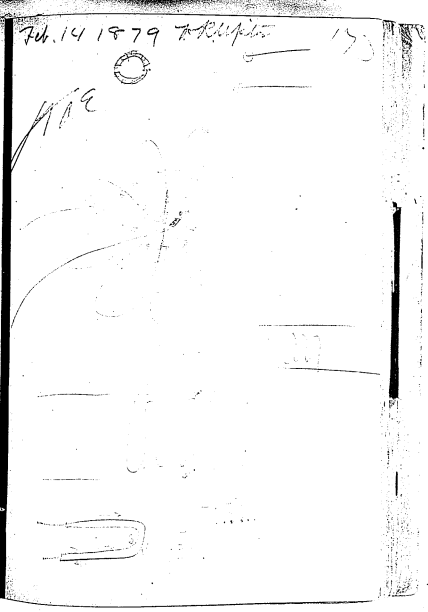
17

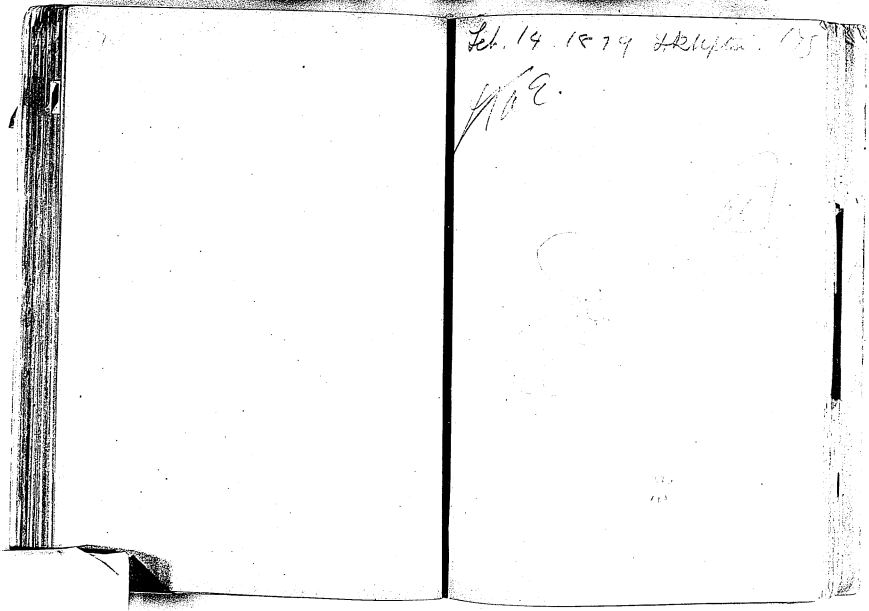


172 Feb. 14 1879 KRUSE

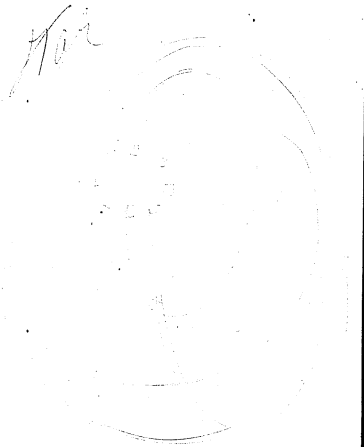


Feb. 14 1879 KRUSE 173




Feb. 14 1879 Harlem
No 9.

Feb 14 1879



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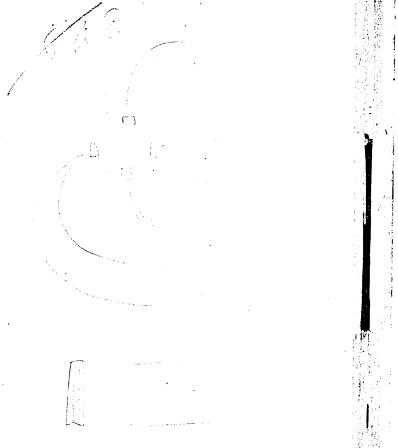

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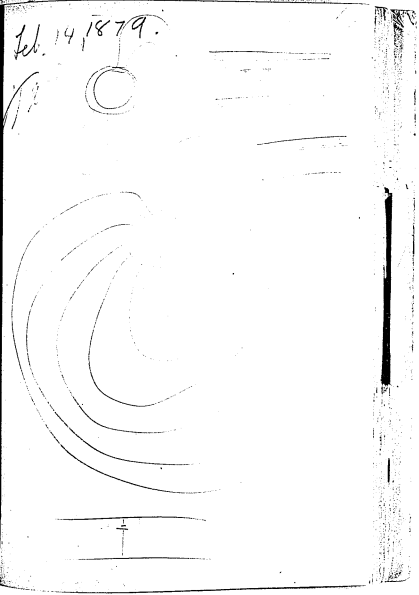

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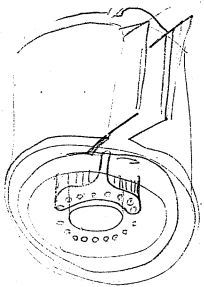

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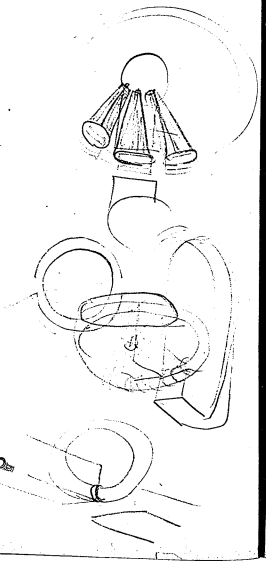
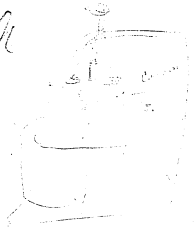


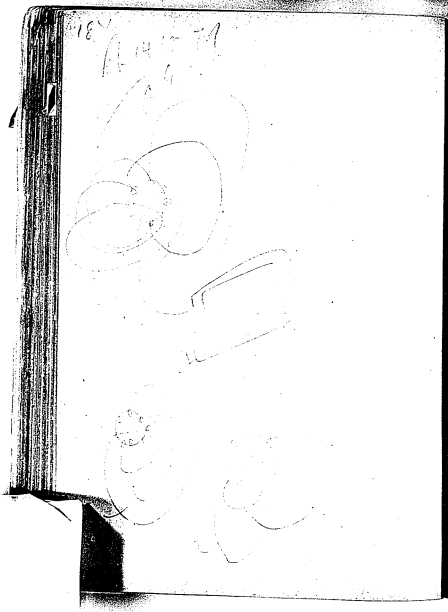
Feb. 11th 1879.

Fig 6

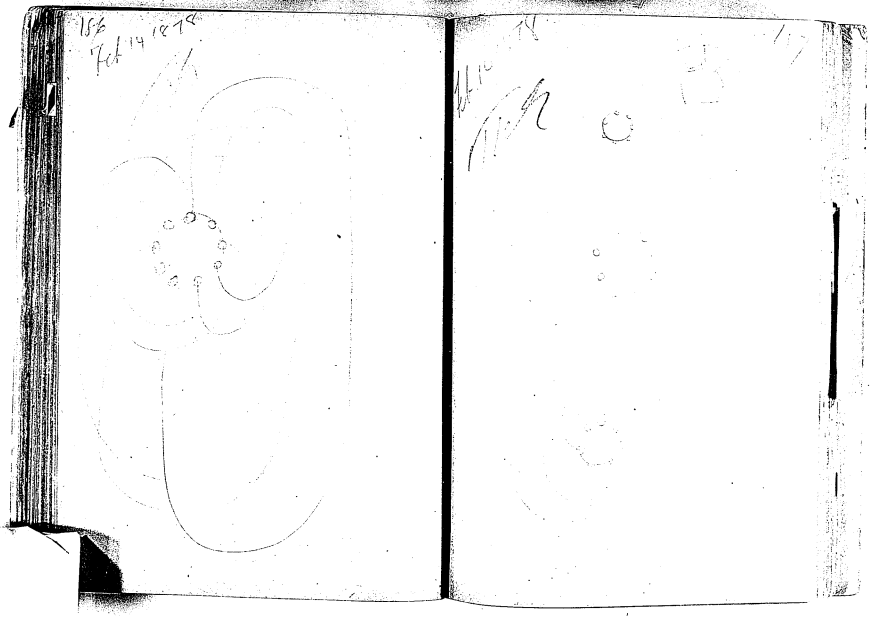


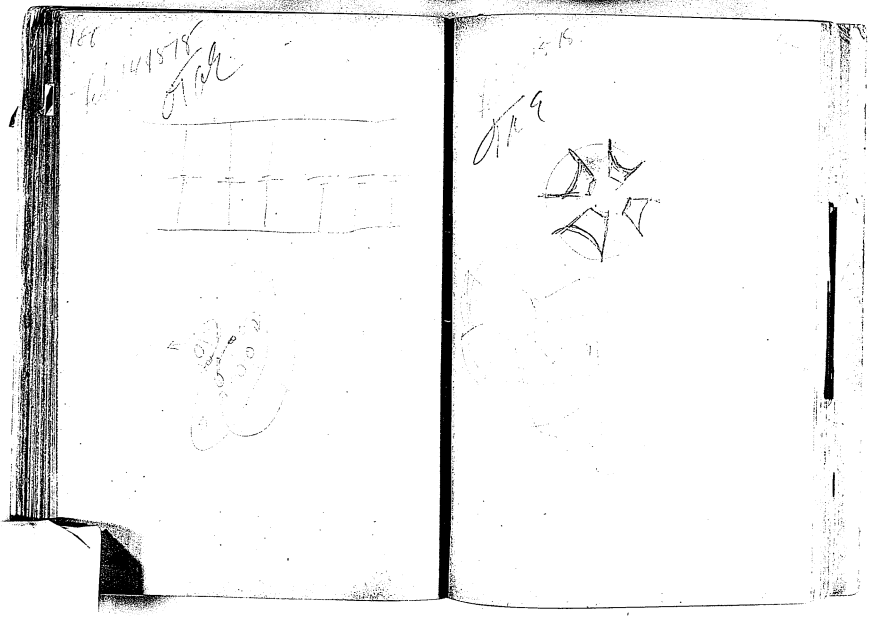
Electric Lamp

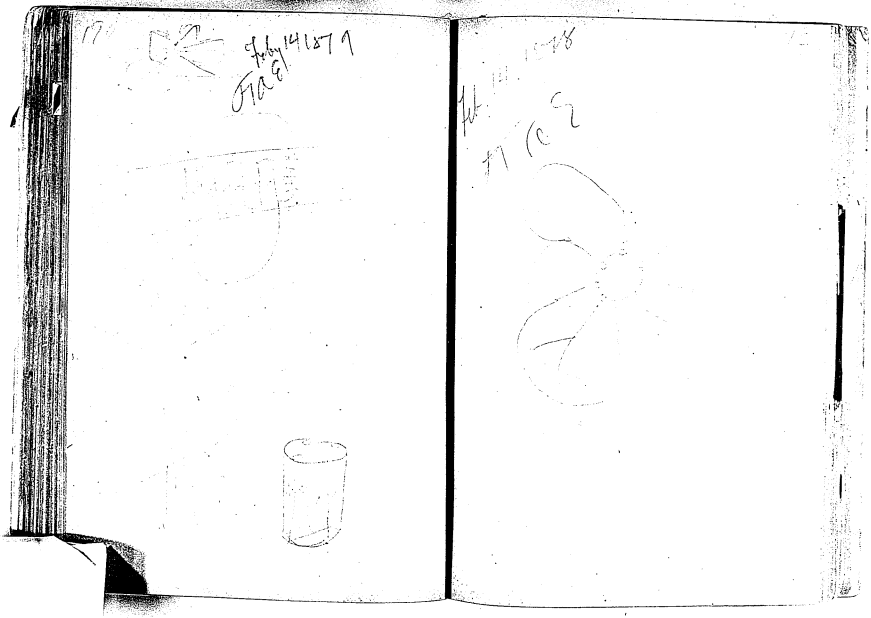
To utilize a current of small E.M.F. and large quantity, as that of a magneto-electric machine, for the production of a powerful electric spark from the Induction Coil.

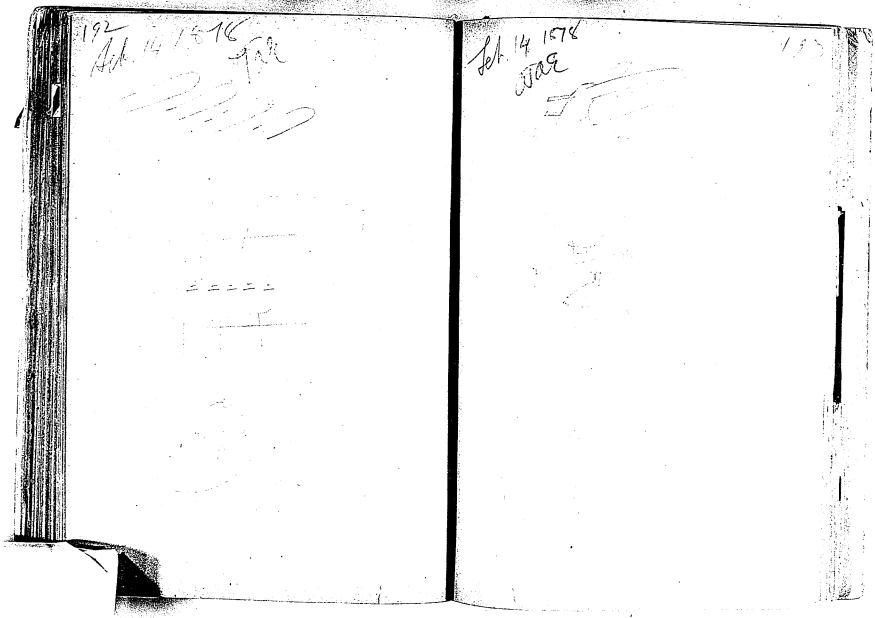


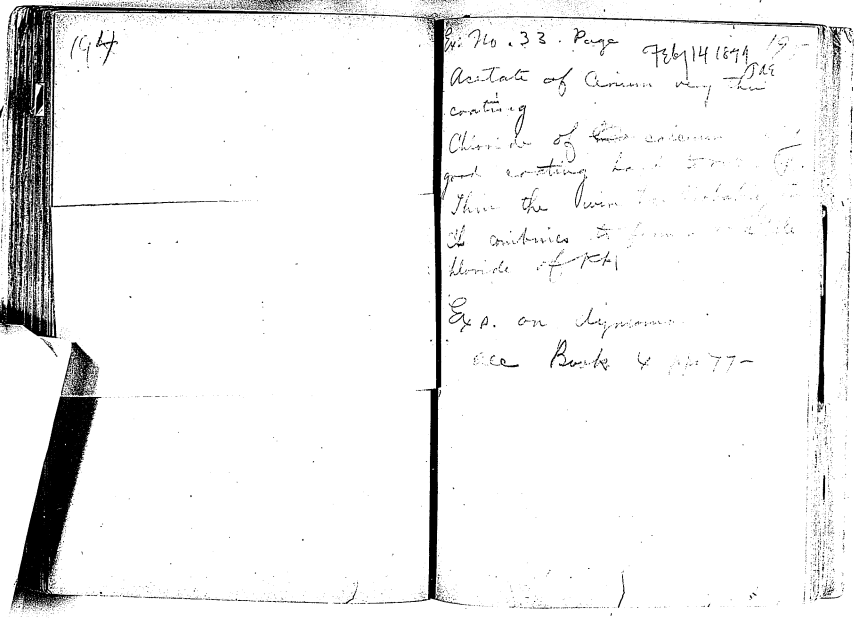
Ex No. 37. Drum and Pt wire sealed in glass tubes. Mr Aprard exhibit.

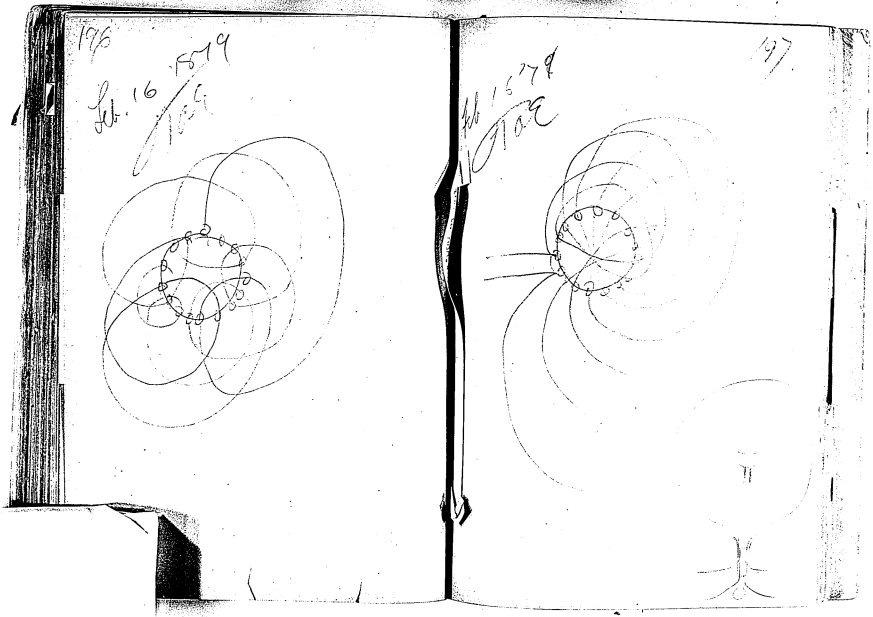






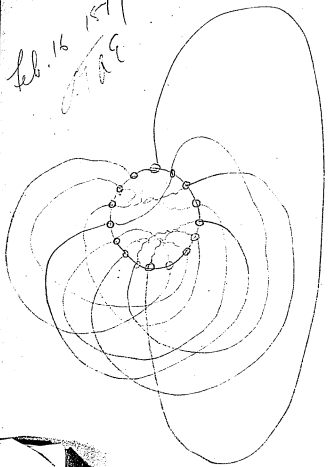





196
97

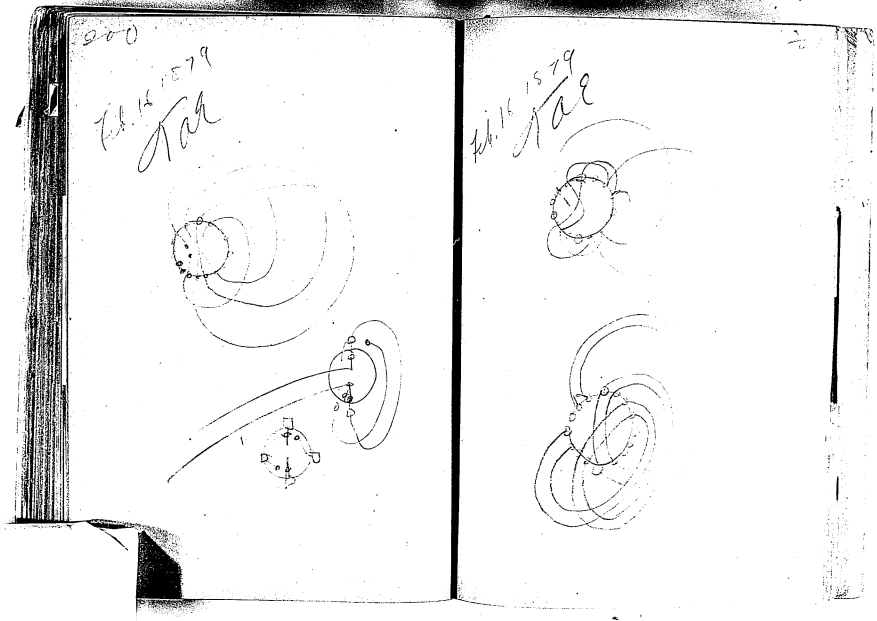
198

feb. 16 1919

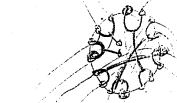


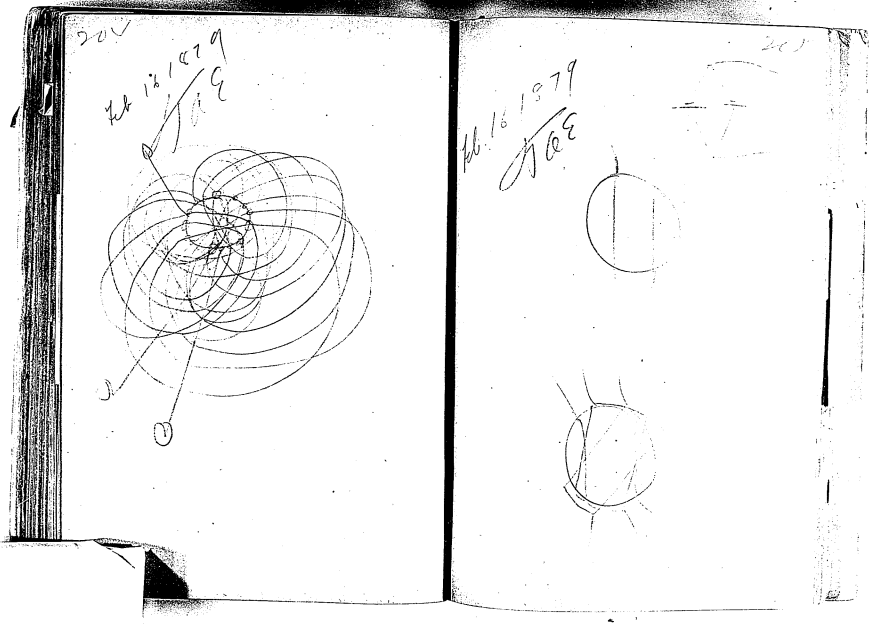
199

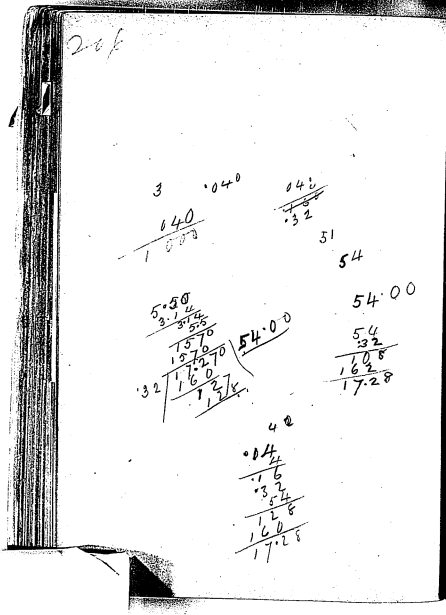
feb. 16, 1919



W-579
Toe




Feb 16 1979
Feb 16 1979

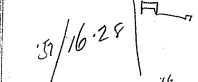


5

$\frac{1}{3}$ ohm

118 = 1

54 ohms



16·28 17·28
14·07 1
.514

25

26

54 coils of 74 turns of 20 wire take up 17·28 inches of shell

each coil ·16 both sides ·32

Diameter .514 17·28 inches

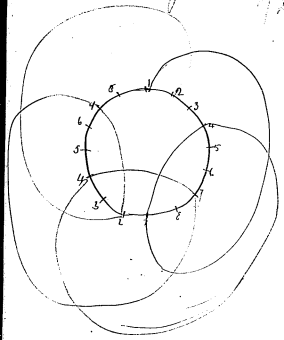
Feathers 4 ¼" inches

Available space for Coils 16·28 each ·32 = 51 coils

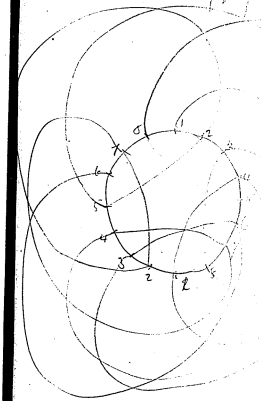
Will 51 coils do.

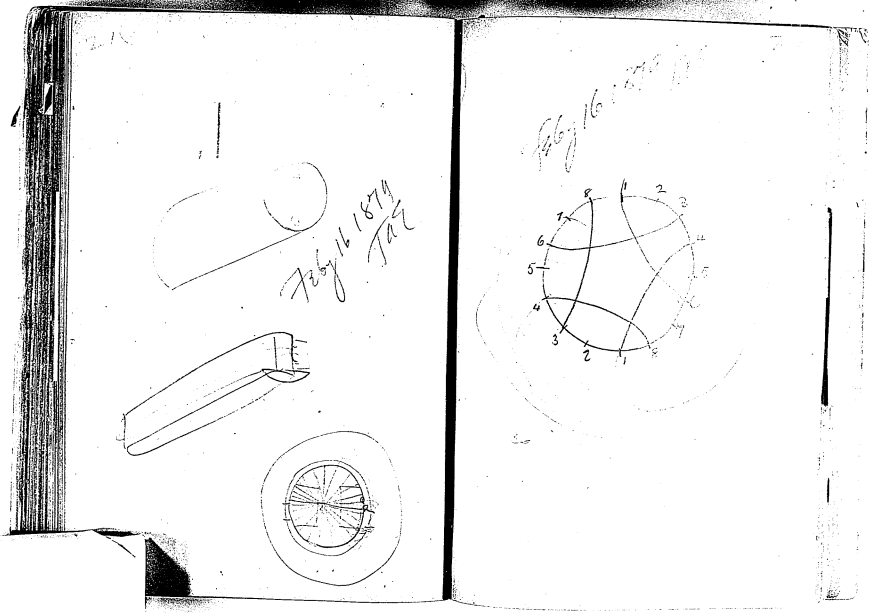
210

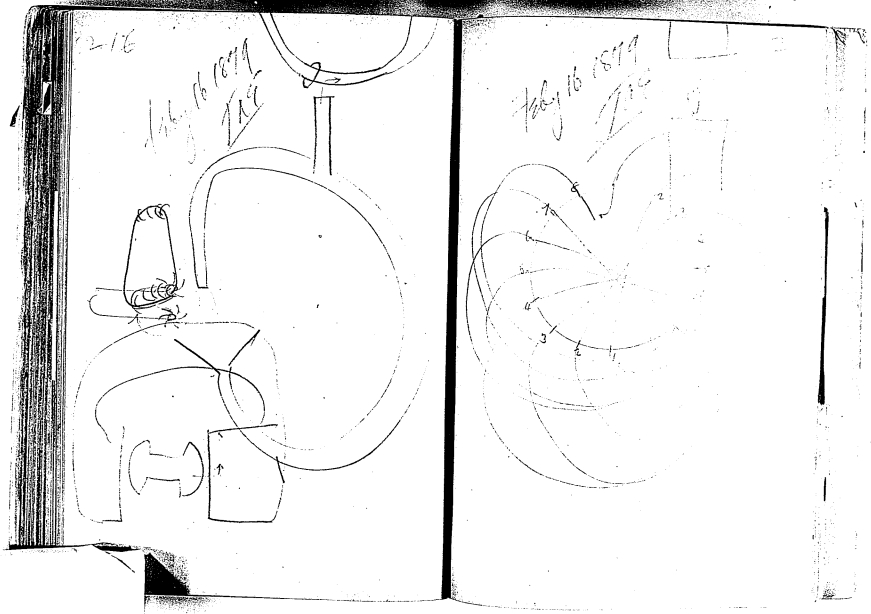
Feby 10 1892

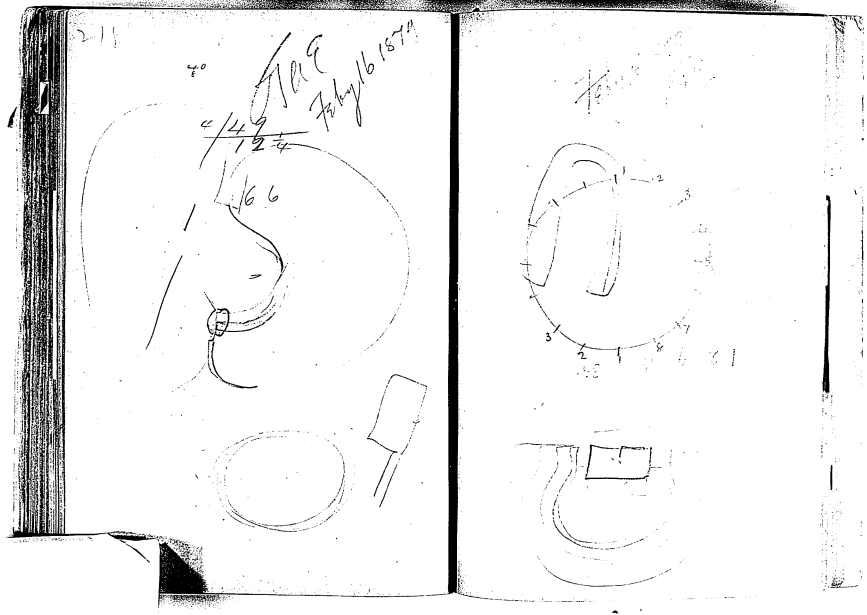


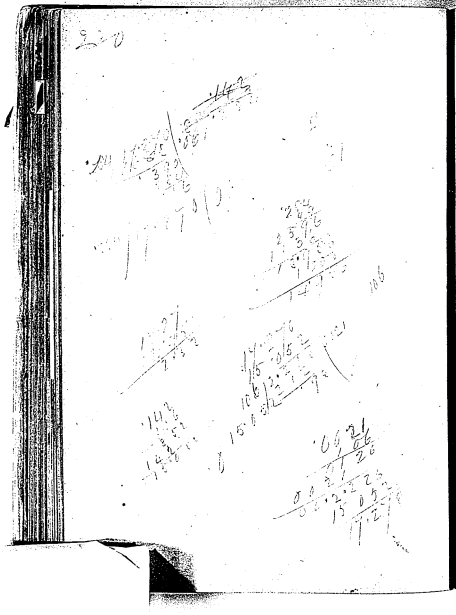
2.12

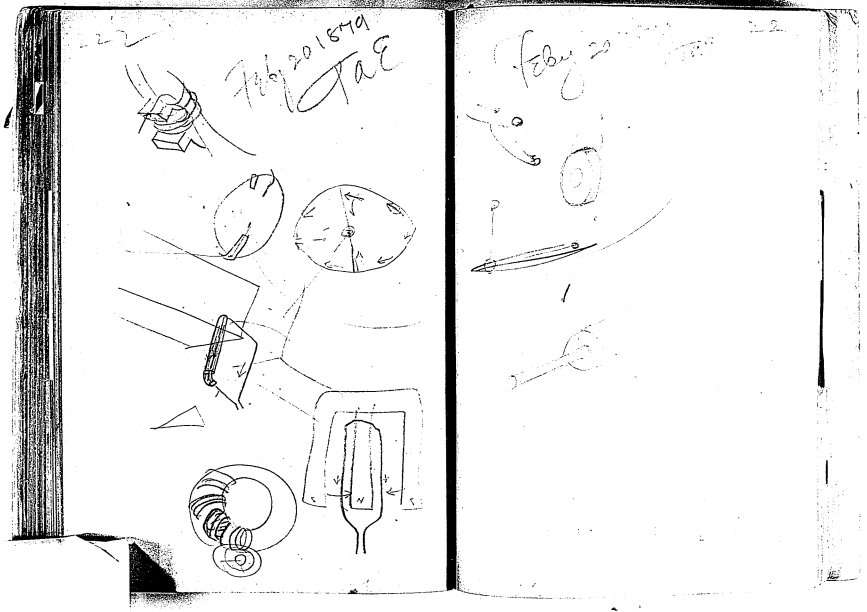


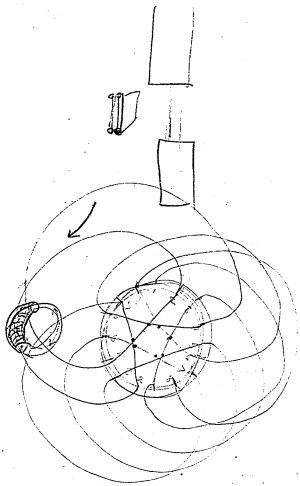

Feb 16 1874
Feb 16 1874
1
2
3
4
5
6
7
8
1
2
3
4
5
6
7
8

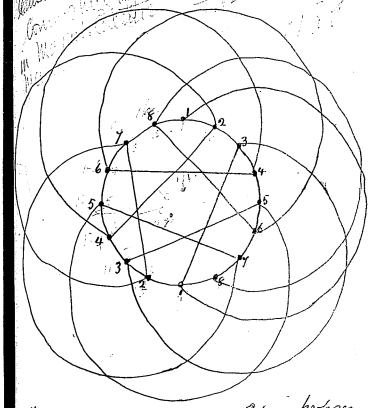




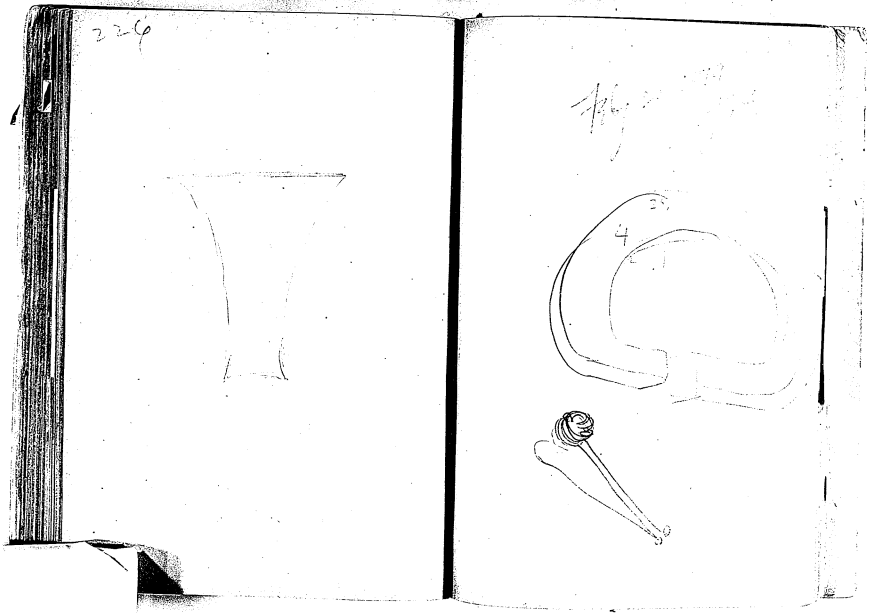








Two ends left open 1. 7 8. Edison prefers
to fasten these two ends to two small commu-
tators as:-



228 Diam .005 in.

.005 in Rt. Platinum .005 3/4

600 mm. R = 8.7 Ohms

Diam .005 B.S. .005 in.

10% Rt. Iridium

600 mm. R = 17.4 Ohms

20% Pt. Iridium

Diameter .005 B.S.

600 mm. R = 15.4 Ohms

Feb 29 1899 JWG

Iron wire .015 + B.S.

60 mm. R = .62 Ohms

Iron wire .011½ B.S.

60 mm. R = .89 Ohms

Primary ○ .17 Ohms

Secondary 58 Ohms

□ Primary .41 Ohms

Secondary 142 Ohms

575^2

500

$500^2 : 575^2 :: 6.7 : ?$

575
575
2875
4025
2675
3306 25

3306
25)

1.32
67
924
792
8844

6.7 ohms

89
15)
445
89
133 5
810

3306
9
13216

62/9
5.58
11

6.7 ohms
8.8 ohms

30.
6
180

27 feet, 6 11. wire

4
108.
24
540
216
2700 (675
24
30
25

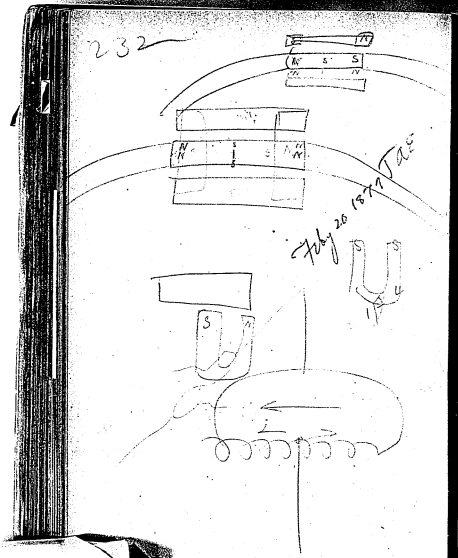
5.58
15
2790
558
8376

17
3

27. 6.

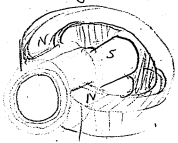
6 27

7


N
S
N
S
N
S
S
N

N
S

Feby 20 1879 Tar



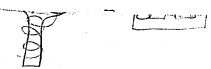
Feby 20 1879 Tar

Edison Laboratory Note Book No. 14.

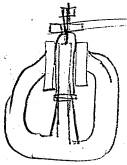
Page 225.

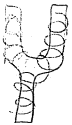
See Edison Patent:

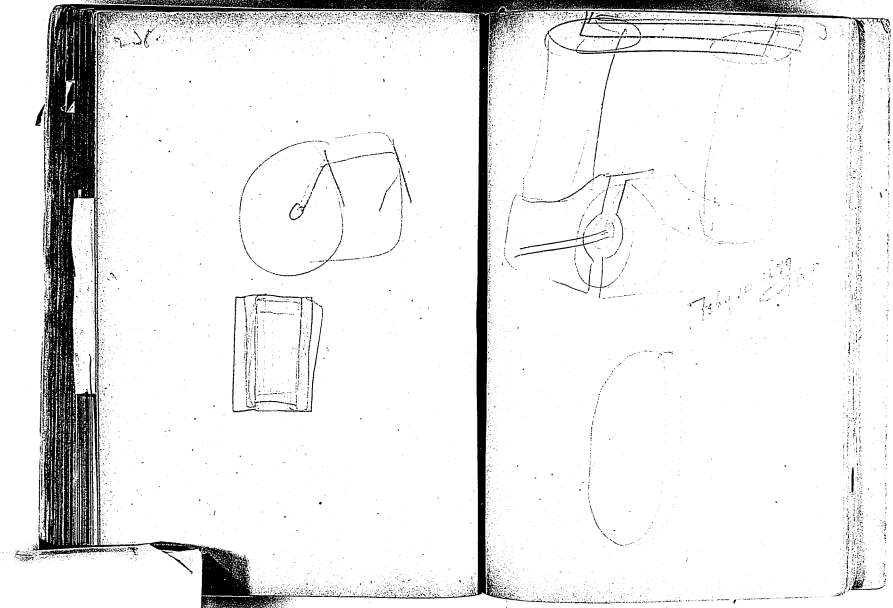
370,128 (Pat. Sept. 21, 1887.)



Febyzo 1879 Tar







240

4 in. Quot.

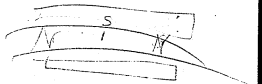
$\frac{4\frac{1}{2}}{25} \quad \frac{1}{50}$

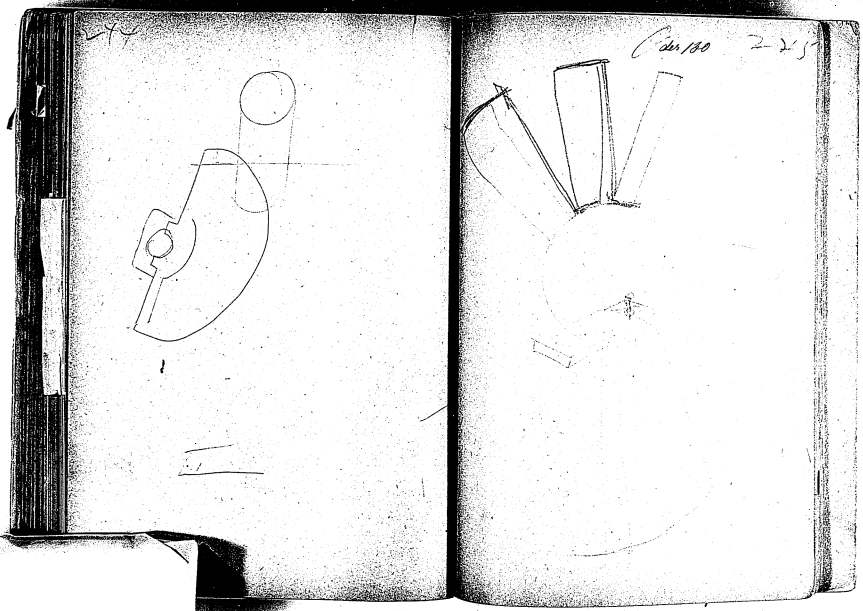
17.

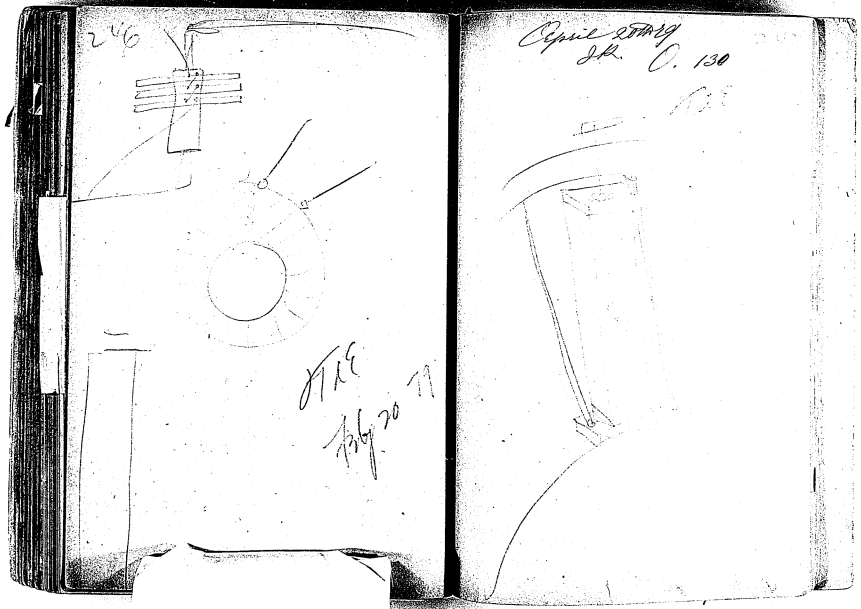
$4\frac{1}{2} : 3 :: 25 : ans$

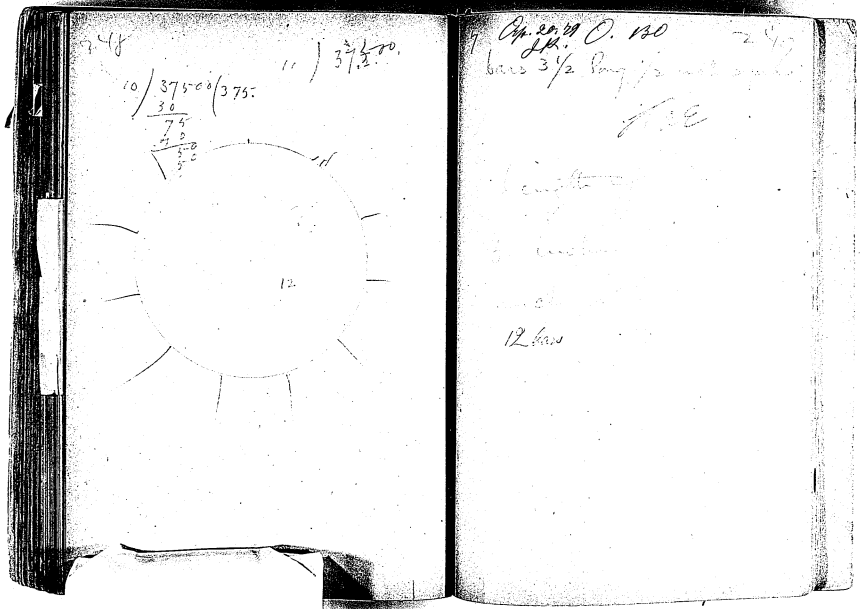
$4.5 \overline{)75} (17.$
45
300

15


S
N
N



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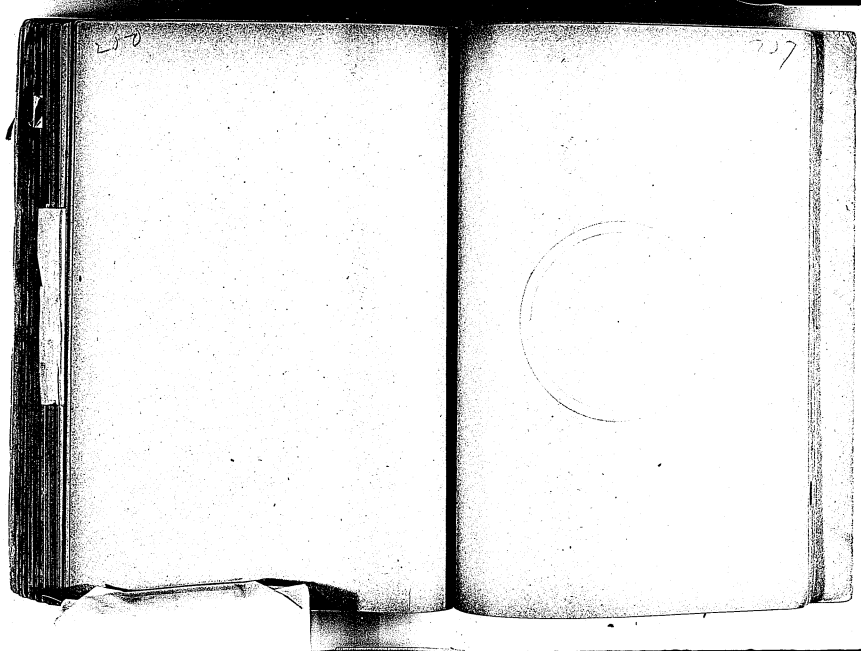
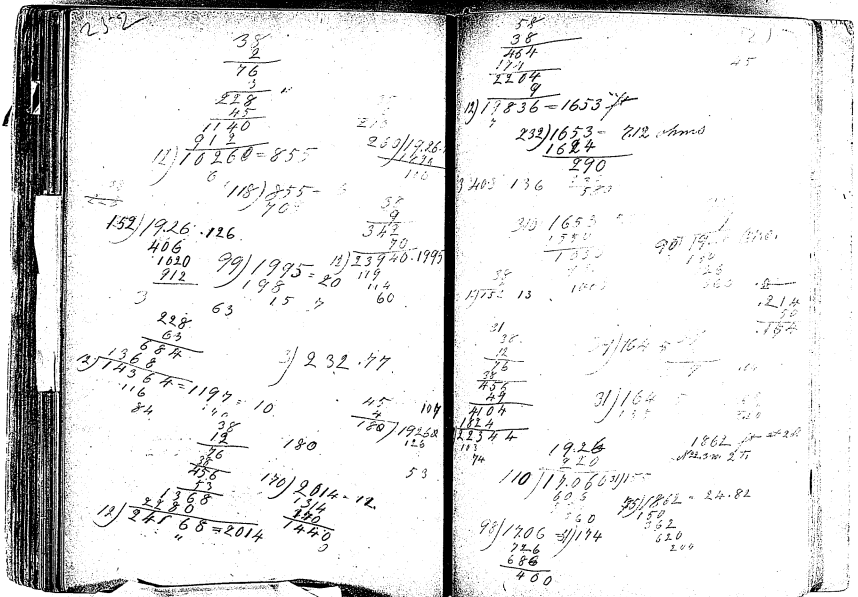
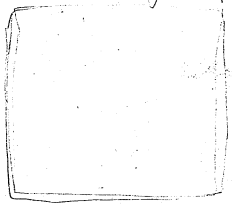




450
92

450
6
2700

9 / 54000, 600



600
9
5400

4

120,

33

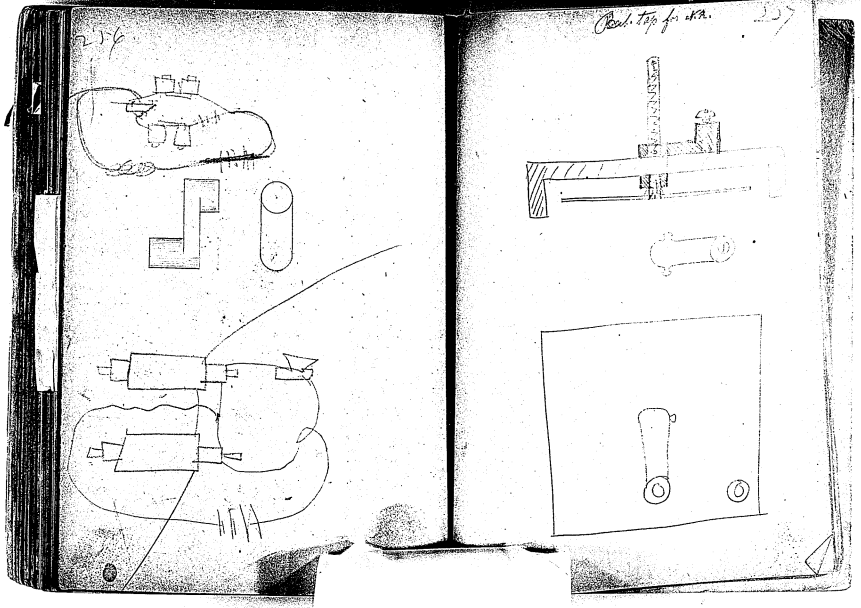
weight – 27 lb

diameter

1500 r

18.000

20.



215.

$\frac{1}{3}$

b = resistance

Let a = orig lamps

$\frac{a}{n}$ = multiples

$\frac{1}{a+b}$ = orig current

$\frac{1}{\frac{a}{n}+b}$ = multiple current

$\frac{\frac{1}{n}}{\frac{a}{n}+b}$ = current in each lamps

1997
998

$\frac{2000}{2001}$ .999

$\frac{1333}{1334}$

$\frac{1000}{1001}$

$\frac{800}{801}$

60

666.66
667.66

571.4
572.4

500
501

444.44
445.44

10 lamps

400
401

6021
6031 .997
.9990
.9980 .9955

15 lamps 4000

266.66
267.66 .9925
.992 .9929

20 lamps

200
201

21
.9979
.9958

.990

25 lamps

27
.9973
.9946

.987

262

32 lamps

125/126 — 35 — .9965 — 2 — .9930 — .984

40 lamps

10/11 — 0414 — 9586 — 2 — .9172 — .826

1656/828

100/101 — 43 — .9957 — 2 — .9914 — .980

4/5 — 6021 — 6990 — .9031 — 800 — 2 — .8062 — 640

1280/640 Table

20/1965 — .982 — Table

200 lamps

20 — .3010

21 — .32222 — .9788 — 2 — .9576 — .907

1814/907 Table

3000 — 2/3 — 3010 — 4771 — .8239 — 2 — .6478 — .444

1888/444

18½

19

36 inches 3 feet

99999 250 feet

3.15
85
1575
2520
26.775
.200
3387
134
67

67. commutator
divisions .200 for
wire

250
.200

67
3
201 feet around one wire
continuously

$\frac{170.6}{(.042)^2} = \frac{20.1}{x^2}$

1/4 #/m

20.1 2.3032 .045
42 2.6232
42 2.6232
comp 170.6 7.7681
17.3177
2.6588

.045

4 | 250
62.5
3
187.5

Core 8 3/4 / 8 3/4

26.77 1.4276
.187 1.2718
2.1558

143
71
2
213 feet

62.5
12.5
50

241.9 : 213 :: 25
25

213 2.3284
25 1.3979
241.9 7.6151
1.3414

21.9
.219 Ohms one turn

219
4
3 | 876
.292 Ohms

.049 75 commutator

8.75 9.25 9.5
9.5
1875
2
12 | 37500 inches
3125 feet

8.75 .9420 9.
3.16 .4997
1.4417

27.67

Make core
9 inches
62.5
2|2.75
1.375 1 3/8 inches iron

3.14
9
28.44

4|260
65
65
12 covers
53
.195

28.44 1.4539
.195 1.2900
2.1639

2|145.8
73

18
18.5
136.5
3.04
73
912
2129
2219 2 feet

241.9 : X :: 50² : 53²

241.9 2.383836
53 1.72432
53 1.72432
comp +5ro 6.60221
2.43443

2.38384
6.60221
8.98605-10

272 feet

272 : 221.92 :: 25 :

2.3462
1.3979
7.5654
1.3095

20.3
4
8.2
26.4 Ohms

.264 Ohms

73 coils wound 4 layers
wire .0503 in. in diameter wound
in in three

1268

67

12 covering

55

28.44 | 1.4537
2.07 | .3160

67
3
201

1.1377

137
68 Coils

3.04
68
2432
1824
206.72

8
898 57
55 1.7404
1.7404
2.6765

~~1111~~ feet
299 feet

299 : 206.72 :: 25

2.3154
9.3979 - 10
7.5235 - 10
1.2368

172
4
3 | 724
24.3 ohms

Machine wound

67 coils .055 wire
allowing .012 for covering
four layers of three wires
connected gives .243 Ohms

The thickness of wire
on armature .268 in.

68
4
272 turns

39
12
78
39
468 turns on No. 12

75 commutators

.049
.013
.062
3
.186

2).379
.189

75 Commutators

75 | 2844 | 37.9
225
594
525
690
167
47
13
34

304
75
1520
2128
228.00 feet

on Machine

in

23 m feet

75 Commutators

No. 18 Wire

Distance from
Iron core to
Face Armature

.3
62
3
.186
.19
.376

75
3
225 machine No. 4

702 Machine No. 182

702/225) 702 | 3.1
625
270

1/3 the No. of turns

.625 .7959
.468 .6702
.1257
.1464
.1257 .2718
.0414
.1671 147 Volts

.625 7
.468
140

216

.035 wire No. 20

118.5 feet 1/4 Ohm on machine

228 feet

228 / 114.5 / 1923

2.3579 / 2.0736 / 2843

4 | 189 / 47.25 / 35 / 1225

.481 Ohms on Machine
.12 Ohms one layer
4 wires side by side
2 layers
.24 Ohm resistance

035 / 47 / 2 / .094

75 / 2 / 150 turns

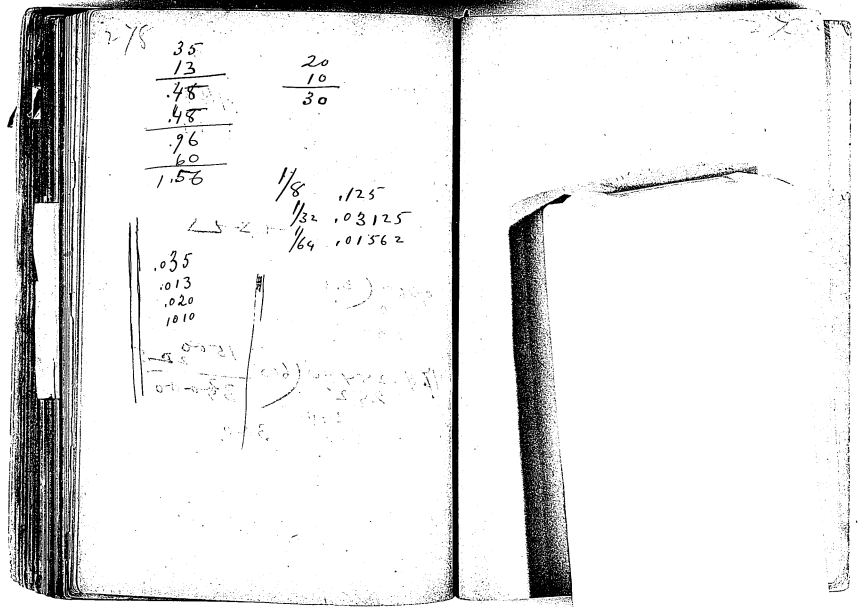
.094
.010
.040
.144
.047

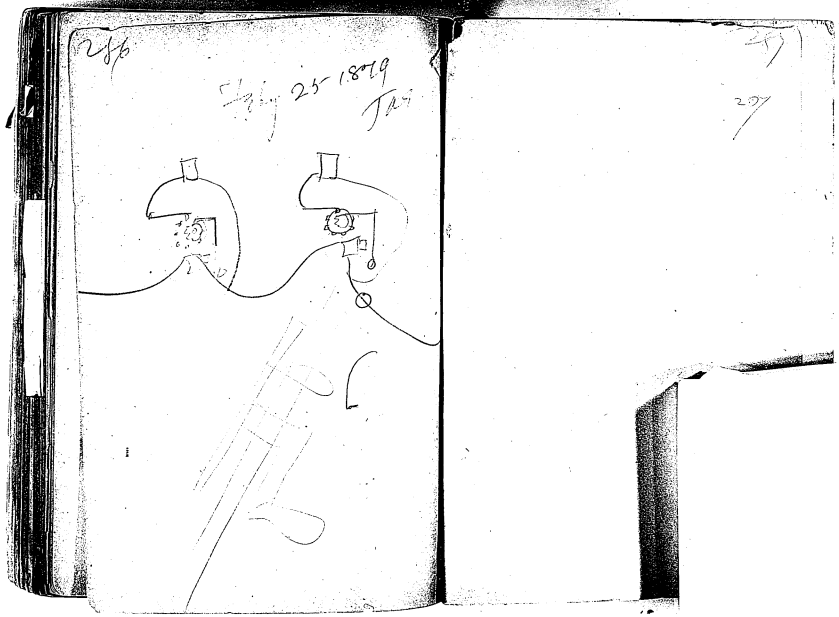
144 | 468 (3.2
432
360
288
720

150 | 468 (3.1
450
180

47# | 28440 (605
282
240
300

1500 / 2205
3300


35
13
48
48
96
60
1.56
20
10
30
1/8 .125
1/32 .03125
1/64 .01562
.035
.013
.020
.010



148 : 12 = 74 :

148 — 1904 — 592 — 148 — 21924

141032
1411
283564
4250496
1133465
85504
1411832
5644328
14118320
19861291624

Menlo Park Notebook #15 [N-78-12-20.3]

This notebook covers the period December 1878-July 1879. Most of the entries are by Francis Upton. There are also entries by Edison and Charles Batchelor. The first page is inscribed "Journal Francis R. Upton Dec. 20, 1878," and page two is inscribed "Dec. 15. These problems given to me when I first came into the laboratory." The first twenty-eight pages contain notes, drawings, and calculations relating to these early problems with electric lighting. Interspersed are notes by Upton on electricity, magnetism, light, heat, the nature of scientific progress, and Edison's work on quadruplex telegraphy; notes on experiments with a spectroscope; and notes on an electrometer. Similar material can be found in Menlo Park Notebook #10. There are also notes, drawings, and calculations on lamps and generators; calculations on thermopiles and batteries; extensive notes by Upton on the gas light industry in Europe and New York, taken from gas light journals for May and July 1879; notes by Batchelor on carbon; and sketches of the telephone. The label on the front cover is marked "Journal," "Gas," and "Upton." The book contains 282 numbered pages.

Blank pages not filmed: 68-81, 86-87, 148-282.

No 15

Pages 1 to 45. "Motor & Brakes on Durham's Power, Electric Motor Co." (Unimportant)

LIBRARY OF THE

BOARD OF PATENT CONTROL,

120 BROADWAY, NEW YORK.

May, 1896

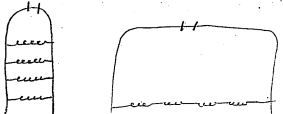
No 15

Journal
Francis R. Upton.
Dec. 20, 1878.

$\frac{1}{100}$ $\frac{1}{10}$ $\frac{1}{4}$ $\frac{1}{2}$

Dec. 15 These problems given to me when I first came into the ~~####~~ laboratory.

Example No. 1



100 lamps 10000 ohms, 100 lamps 1 ohm.

How much heat in each lamp?

Heat = C^2R

Ans the same

No. 2 If ⊖ battery short circuited connected one ag Zn given time how much Zn will ⊖ two cells short circuited connected

$Zn = C^2R$

~~4 oz~~ 2 ag

Ex. 3 Through 1 Ohm outside

Ex. 4 If a two horse power engine will heat a Cu. rod $\frac{1}{4}$ inch in diameter of a ~~to~~ temperature rise being a length of 30 inches how many lamps per horse power.

We look the resistance of the Cu. and of Pt and ~~with~~ of Pt as compared to Cu. do and find an ~~estimate~~ estimate of five or six ~~ohms~~ Ohms.

Ex. 5 In using one ton of coal the same as 1300 pounds distilled to make 10000 Cu. ft. of gas

$5 \frac{10.000}{2000}$

~~In~~ 2000 gas burners for one hour at 5 cu. ft. per burner = 30.000 candles

1300 lbs of coal will run an 650 Horse Power engine one hour.

Jablochkoff claims 600 candles per horse power.

650
600
390.000 candles for 1300 lbs of coal

650
90
58.400

6 lamps of 15 candles per horse power = 90 candles

30.000 candles for gas
58.400 for Arc. Lamps
390.000 Jablochkoff

Ex. 6 How many pounds of Pt. will one Horse power raise one degree Fahr. heat in one minute.

772 / 33.000 (42

One Horse power will heat 42 lbs. of H_2O in one minute

Sp. Heat of Pt .33 to H_2O = 1

42
33
126
126
1386 lbs. of Pt. heated one degree Fahr. in one minute

Ex. 7. Battery 2 Ohms
Lamp 3 Ohms
Electromotive force 8
$\frac{1}{4}$ inch radiating
How much heat Ans 7.7

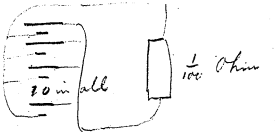
Ex. 8. The same as No. 7 except lamp 6 Ohms Ans. 6.6

Gravitation is not really a force
It is only a condition of
matter. E. the same with
magnetism.

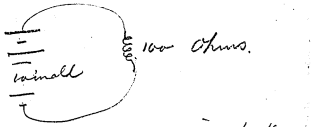
An induction coil may be
short circuited by bringing a
ring of metal round the
field. The first small
Wallace had this defect as on
the ends of the magnets there
was placed a ring of metal.
Edison

Ex. 9 The gearing of wheels
and the weight to be applied
to revolve Magneto machines.

Ex. 10 Heat on wire in this cir-
cuit



as compared to this



various resistances in battery,

Ether Force

If it were electricity of high tension there would be very small testing effects for even large sparks. When the wires are brought to an iron surface for contact, bright scintillations can be seen showing strong dynamic forces.

When a magnet is made and removed the whole air and region about it are thrown in a strong diamagnetic stress. If this stress is removed and wires are left in the field the force will show itself in a spark. If the connection is broken of the wire where does the stress go to? Heat was my first answer, but the following experiment seems to show that there may be a new form of energy.

14

Relays made short to prevent induction. Long magnets give the greatest spark. A short magnet discovers current instantly while on a long magnet the time can readily be heard.

Useless friction or resistance in the commutator much worse in a machine from intensity than in one for quantity owing to ⅓ of loss.

Machine 100 Ohms
Commutator 1 "

1%

Machine 1
Commutator 1 100%

15

Ex. 10 ~~The~~ H.P. horse power costs 8/10 of a ct per hour. hours could can be extended on a machine to save one horse power the machine to run 10 hours each day.

3.65
.008
2920
11 days in year
$29.20
10 interest 10%
$292.00 the interest of

Ex. 11 Why should not a one horse of a coil have as much current as many of its ohms equals resistance, for example the ohms

magnet could be increased in cam bon.

16

Wire used to prevent vibrations
This could be effected with a pad
dampened with rubber. The fin-
ger is the best known substance
for dampening vibrations and
rubber comes next.

Carbon lamps polarizing the machine
must be driven at a higher
velocity to overcome this without
increasing the resistance.

When the holds of coal ships
were ventilated a large vol. were
burned, since the custom has
ceased very few burn. This shows
that there can be a slow com-
bustion of coal, a slow oxyda-
tion at low temperatures. A
battery is an appliance by
which the slow combustion
of Zn. is taken advantage

17

~~Cells~~ to produce electricity. Zn. and
acids cost very much, coal
and air are very cheap, if a
battery could be made using
coal it would be extremely
economical. There might be,
for example, large cells into
in which coal could be dump-
ed, and wires fastened
away. Carbon and Oxygen have
the most powerful affinity
for each other of any known
substances at high temperatures.

Large thermo piles might be
made to utilize the heat of
it came from the combustion
of coal!

If the world were to go on for many thousand years more, there would seem to be no reason why men should not go on discovering and inventing. No reason to doubt that new tricks and arrangements will be made so that Nature may work to our advantage. The scientific journals will go on publishing. Poggendorff's the Philosophical Mag. will be filled as now. It is too much to ask for men today to be afraid that they cannot find out anything that all has been formed.

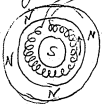
Men are just beginning to propose questions and find answers, and we may be sure that no matter what question we ask, so long as it is not against the laws of nature a solution can be found.

What is now to be solved is this question. To take the heat from a large coal fire under a boiler and carry to various points where its intensity and utility it for lighting.

If it were not for the light would not be detected by any known reaction, except the decomposition of a few salts and the indications of the thermo-pile. If the rose were blind to the light rays as they are to the chemical rays and

at last eye which could measure hot rays. It would have been many years before the existance of light would have been suspected as it was many years before the chemical rays were conjectured. On the doctrine of conservation of energy only a small fraction of the total energy is light. For example, according to Thompson only $\frac{1}{100}$ of the energy of a gas flame is light, and current experiments have a longer probable expense than this.

Ex. 13 Why should not this machine give a constant current?



Wire revolves

Ex. 14.

wire still

To be tried. a ring of steel and a current passed round in a coil wound completely round to break the ring and find whether it is magnetic.

A Bell telephone will answer taste on the return beat of the diaphragm thus giving an echo on what corresponds to one echo. Thus a simple tap on one diaphragm will be by this echo made into —

Clocks may change their rates ~~too~~ as their position is varied, as the pendulum may strike upon the movements and thus retard it.

—

Ex. 15

Would this give constant current

Ex. 16

Ex. 17

Wire wound in the form of a fig 8 and revolved

No current

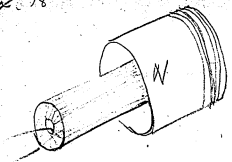
Mr. E. says that he always considers in working for the quadruplex that he was only working for one room to another and thus he was not confused by the amt. of wire and the thought of the distance.

Phosphorescence may be called the induction of light. The induction of Elec. means that matter is put under a strain which when removed gives a current. Thus a substance exposed to light is put under a strain wh. when removed shows itself in the form of light.

In looking through the spectroscope Mr. E. noticed that the light the sky being partially obscured would vary greatly in brightness. These varied undoubtedly be a lighting up of parts of the spectrum resembling the lines of the metals some hours and at one time noticed the phenomena of ~~in~~ with great clearness and saw that a very small cloud could be seen.

Why could not a diffraction grating ~~be~~ be made by rotation

Ex. 18



Wire wound on wooden core and rotated. Would this be a magnet?

Ex. 19

Wire wound on inside coil between the two poles.

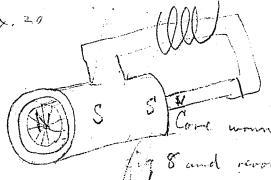
An electrometer may be considered as a galvanometer of great resistance. For example a 20,000 Ohm galvanometer will give indications exactly corresponding to the electromotive force of a battery. If we could have a galvanometer with a resistance equal to that of an inch of air it would give almost perfect indications of electromotive force E

The electromotive force of an element is dependent on the chemical force existing between the substance and the exciting

The amount of electricity de-

depends on the number of molecules

Ex. 20



Core wound in fig 8 and reversed would it give a resultant current?

The question as to the winding

If the current from a Bell telephone is ~~not~~ received round a soft iron core very little effort is produced. The current is lost in twisting the molecules

Vol II Phil. Mag. P 135

Mention of Authors process.

Jan 12

~~The Cells~~

Electromotive force of Battery

Callaud's cell 1000 Ohms +

$D = 24° + 1°30' = 25°30'$

Daniells

$17°30' + 1°30' = 14°$

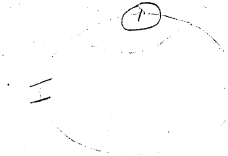
tan 25 30' .476

tan 14° 249

249)475 (1.91 Daniells
249
2270
2241
290

Make a ~~Solution~~ collection of different kinds gums and with a paint brush paint ~~round~~ a number of ~~buttons~~ carbon buttons on their edge one with each — mark on paper what each are and let us see how they stain

- Arabic aq
- Tragacanth "
- ~~Dextrine~~ "
- Damar alc
- Dammar Amm aq
- " Resin aq
- Ammoniac alc
- Myrrh alc
- Opoponax alc
- Sandarach alc



Calland ~~cell~~ played out
Electromotive force = 1.9 Daniells

measurement can have always
outside resistance

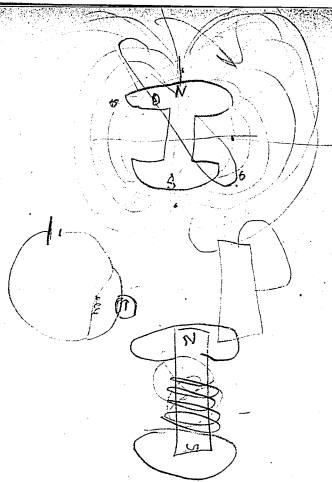
Frank Calland

31° 0'

Daniells
1.6 J

600
32

32) 60 (1.87
32
280
256
240



Resistance Bradley Galvanometer

1 150
2 38 Ohms
3 1.2 Ohm
4 Trafo

Small galva about .5 Ohm

1 spiral $\frac{1}{4}$ surface 10 ohms
4 " 1/2 " 40 "
7 " 3/4 " 70 "
13 1 $\frac{1}{4}$ 130 "

23
1 0
2 3 0

7/H 3 3'

1 3/4.

1/4
0 10

1/2 40

4 1 1/4

1/2 10

2 inches

0

0 0
0

0 0

Wt of Nail

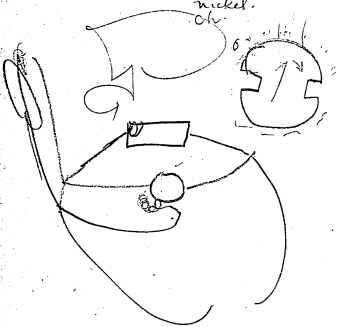
5 - 10½
9 - 5½
9 - 15½
9 - 7
34 - 6

Pt stirred Pork 12 Pt 70

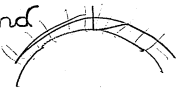
Resistance

Cold	4.6	
Warm	5	
Red	9.3	9.6
White	12.	13.5

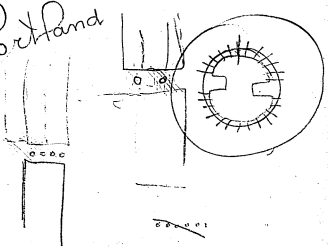
Sulphide from Tin load, zinc nickel. Cu



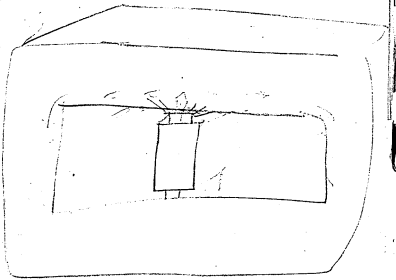
Round



Portland



Portland



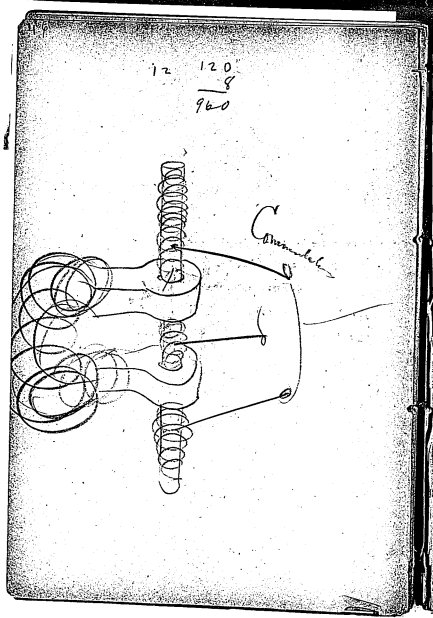
R

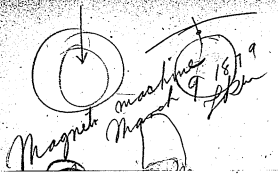
S

Round

Writing

Round
Writing





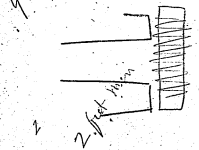
Edison Laboratory Note Book No. 15.

Pages 46 to 53.

Dynamo Sketches.

See Edison Patent:

219,393



12 120
8
960

Magnet machine
March 19 1879

4 feet.

2½ feet wide.

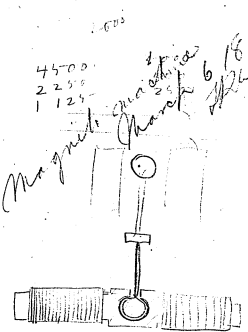
Edison Laboratory Note Book No. 12.

Pages 40 to 52.

Dynamo Sketches.

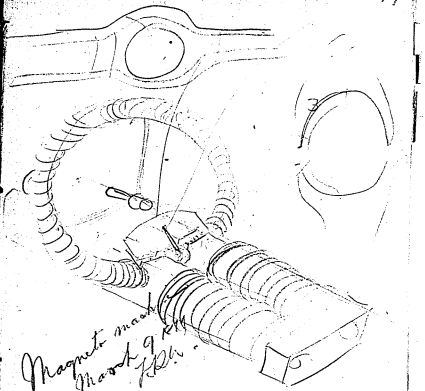
See Edison Patents:

212,704



4500
2250
1125

Magnet made March 6 1899

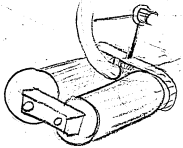


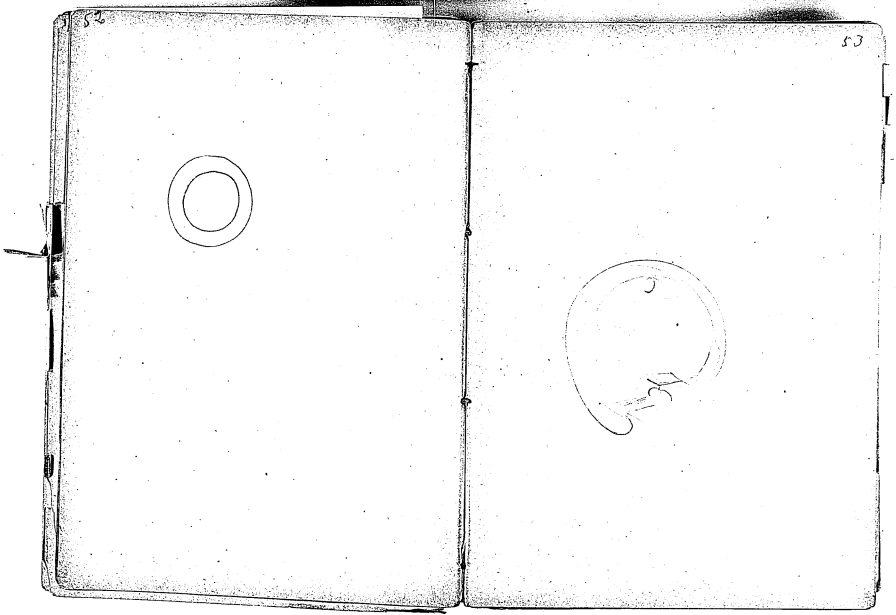
Magnet made March 9 1899

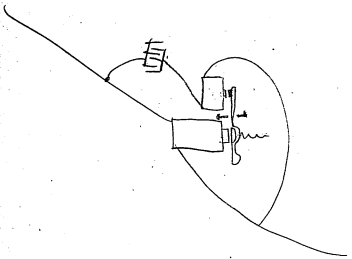
20

700
9
6300

Magneto Machine
March 9 1879







Thermo piles

For plating

$\frac{1}{10}$ Ohm in cell

Current is the only factor that is efficient

$\frac{1}{2}$ Daniells

Cost of Current from battery or Faradic machine as the equivalent of the current $\times R$

C^2R = Cost

For example

~~1 Volt~~

Unit of energy the energy given off by one Weber on one Ohm

Faradic

$\mathcal{E} = 20$ Volts

$R = \frac{2}{10}$

$C = 100$

$10000 \times \frac{2}{10} = 2000$ units of $\mathcal{E}$

$\mathcal{E} =$

In Thermo like, current does not cost directly it is the E.M.F that costs. ~~For example~~ The heat that is required from a thermo cannot be so much in excess of that required that if a fraction only can be used the thermo must be very unprofitable in the meantime

say $\mathcal{E} = 1$ Volts cost 1 on
R total $= \frac{2}{10}$ Ohms Thermo
$C = 5$ Webers

$2.5 \times \frac{2}{10} = 5$ units of $\mathcal{E}$

Cost 5 on Faraday to battery

$\mathcal{E} = 2$ Volts
$R = \frac{2}{10}$
$C = 10$ Webers

Cost 20 on Faraday to battery.
cost 2 on Thermo

Gas Lighting

Page 1 scrap book

In a paper read by Mr. C. E. Jones of Chesterfield England before the Association of Gas managers May 1879. It was said: "The chief requirements of public lights are — (a) steadiness of flame — not susceptible to atmospheric commotion; (b) uniformity of intensity; (c) great penetrating power; (e) ever available without preperation and easily lighted; (f) non liability to any sudden or self extinguish-

ment; (g) shadowless; (h) commercially cheap."

He speaks of the bad designs for street lamps by which useless ornamentation is used cutting off the light.

Regarding glass for lamps
A small proportion of oxide of iron gives a dark color to glass. In selecting remember that next to brilliancy the power to resist atmospheric influences should be considered.
In many places the polish destroyed by atmospheric
Most economical clear brilliant hard glass
The rougher glass is the sooner it becomes dirty.
The loss due to the glass varies with the intensity of the light, and distance from it.
The longer and more powerful the flame the less the loss. Average loss generally stated 9%

Poor glass smoky intercepts 83.8 % of light
after cleaning 16.9 %
Ruby glass intercepts about 50 %
Blue glass " " 38
Ground " " " 22.3 %
Yellow " " " 11.6

Pipes eaten away and gas affects the pipe making often bad leaks

In London lamps cleaned twice each week, in many places once a week
Normal rate of consumption five feet an hour

408 England Stourbridge

25
40
$10.00 for 2400 hours street lamps

log $2.25 to $2.50 per lamp

2400 / 12.500 (.52
12 000
500

5.2 miles per hour per street lamp

Newcastle

5 feet of gas an hour
Local burners 13.68
power 10.54

Street lamps 60 to 100 yards

Roughly lamps use
7.41 to 4.91 feet an hour

Main lights 80 lamps
5-0 minutes

Corner of streets stronger light

Lamp posts 10 to 11 feet high

Main light 105 lamps
speed four miles an hour

Ton of coal in retort
14 cwt ~~6~~ coke

25% coke used for heating retorts
~~13 6d~~ 10 cwt for sale

13s 6d for coal = $3.37
Coke & fittings 100 6½ = 2.60
$ .77 per ton

Waterloo bridge furnaces to E. L.

2½ cu. feet 7 candles

5½d per hour 43 lamps

11 sts 43

43) 11.0 (2.5 — 2.5 mills

86

240

215

5

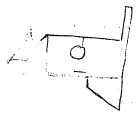
¼ ch per hour

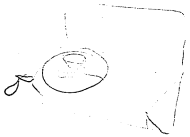
Suggs. Large burner

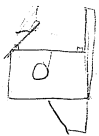
4 candles per cu. ft

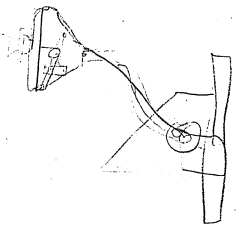
£2 50 per ton for Coke in England

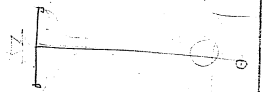
Pages 67 to 82." B L A N K".

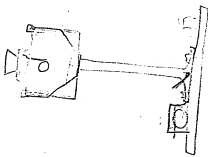


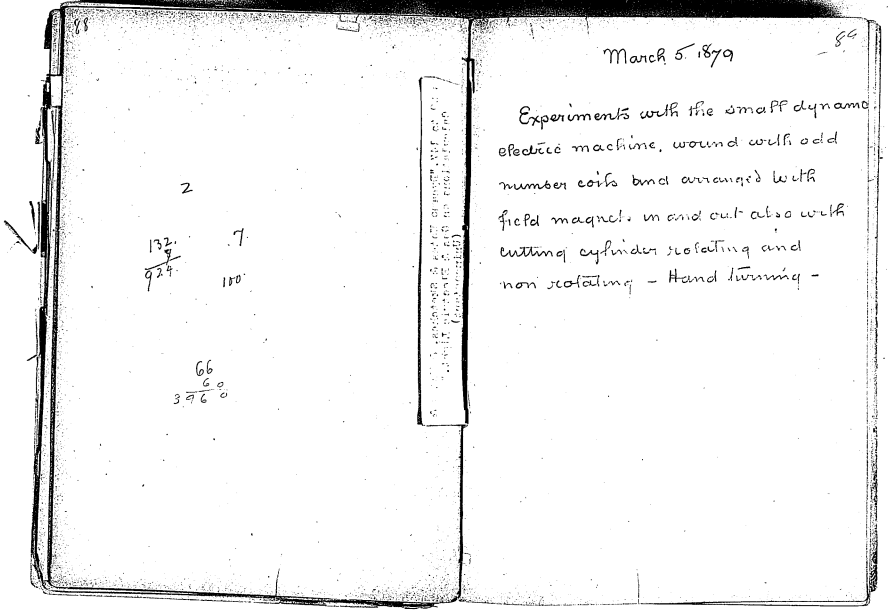












March 5 1879

Experiments with the small dynamo electric machine, wound with odd number coils and arranged with field magnets in and out also with cutting cylinder rotating and non rotating - Hand turning -

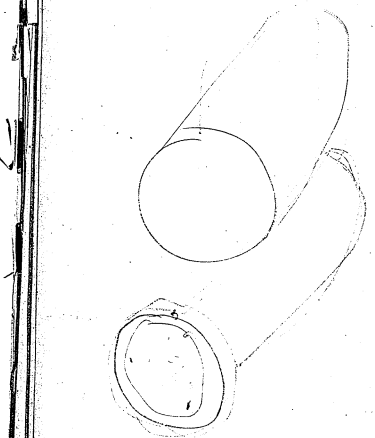
2

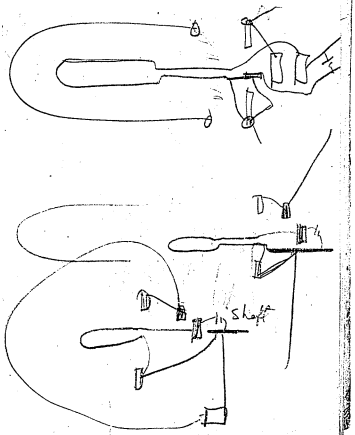
132
9
924

7

180

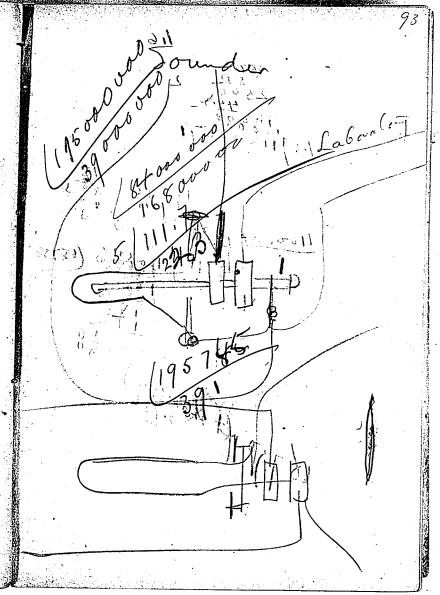
66
6
396 0




Shaft

92

93



94

1.6

50
500
2500
4444
10000
100000
110000

1.6) 110000 (68.75

16) 1100 (68
96
140
128
120
112
80
80

16) 1100 (68.75
96
140
128
120
112
80
80

95

Battery

Body

1000 feet

$5.00
50 cts
5 | 195,000,000
39,000,000

~~178,000,000~~
7,484,000,000

7.5 | 39.15.20
35
150

Paris $5.20 investments
1,000

5 20

-25
1,000,000
10,000 stations
in 150 Paris

365
25
1825
730
8125

8
5
$40

20510
stations
in Paris

8 | 7,484,000
935,500

365 | 7484000 | 2051
7300
1880
1825
550
365

20570

98

$300,000

$30 a lamp

8) 3000 (3
24
.37 cts interest
.26

8) 3.0
.37
.26
.63 cts

to sell at and pay
100% on investment

99

30.

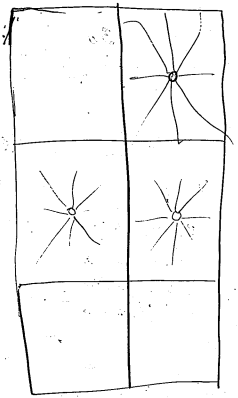
200200

$30 30

4 lbs of coal
10 lights 1000
$35 1000

~~$40000 $60~~

4 lbs 10 lights
4000 lbs an hour
20000
$35 — give hours run
$20 wages and oil
$10 extra
$65



10000
25
250000

250 | 65.00 (.26 cts
500
1500

40 000 000
$ 8 000 000 Expenses
7.884,000,000

74.800,000
34,000.000
40,800 000.
4.0

54.000.000
10.800 000

74 | 108 (1.40
74
340

102

£ = ₶500

55
15
825
86580
5
432500

63725
5
489) 318,625 (6.5
2934
2622

54,654) 432,500 (8

max quantity left works in 24 hours 296 tons

365) 54,654 (149
365
1815
1460
3554

250000

103

Hereford
Journal of Gas lighting
May 27, 1879.

₶ 318625 borrowed
₶ 54000 at present 45700 M cubic feet taken
₶ 6500 capital
₶ 6.50 on. feet

Max. quantity produced 275 M
Max quantity in one day 296 Tkd
Average " " " " 149 Tkd
Lost 10.42 %

10 Tkd sold for ton of coal...

398
81
479) 810 (17
479
3310

9 401
5
47,005

5000 | $1.00 546 54
5683.16

5372/5
26860

54654
1704
218516

54.6 00
56 80
489 20

490) 537 (1
480) 2680 (54
2400
2800

922 2/5
461.0

4012
1173
2939 5
4645

49,000) 4,610 (9
49.000
14690 (29
98
489 F

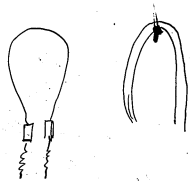
39.863 Shd Private
8.183 " Public lamps
83% private lamps
17% public

Sold $100 per M

~~Total~~ Cost 54 cts per M including exclusive interest & calls other not counted
actual cost 45 cts per M

Interest 29
Total cost 74 cts

Interest 4 4 1/2 per cent on loans



·81

3·1) 1062

London
Profits rising from
3% in 1851 to
10% in 1862

Albert Hall average
use 43,000 cu ft. a night;
25000
30 sun burners
each 105 fish tails
consumption at rate of
2½ per fish tail for sun
burners 7875 per hour
With such burners 1 cu ft.
will give 1½ candles
7½ candles five feet
Total candles 11.862
also in wall burners

Q. 5460
3
1.5480

27 3.2
3.2

35 cu ft one metre

8.721.500
5
43.607.500

690.000
5
3.450.000

London 864.014
5
4320.070

1.162.000
5
5.810.000

500.000

290,000
5
1450.000

London £ = $3.00

6 Companies
Capital Employed

Chartered	$4 3.632,500
Commercial	3,450,000
London	4.320,070
Phoenix	$5.810,000
South Metropolitan	2.500,000
Surrey Commercial	1.450,000
Total	$ 11.162.570

Capital employed per 1000 feet sold	
Chartered	$ 4.10
Commercial	$ 2.75
London	$ 3.43
Phoenix	$ 3.52
South Metropolitan	$ 2.52
Surrey Commercial	$ 2.87

Best $2.52 in ℔

8

$20.16 per lamp 8 M per year

$20.16

Estimate $250,000

10,000

$25 capital per lamp

1

1/8

2 Ohms 60 lights 1/8 H.P.

~~H.P.~~ 2 Ohms

11 55 lights

$3 a light dynamo

$7 conductor

$8 ~~H.P.~~ Engine

$1 Boiler

2

$21 per lamp capital

~~London~~

~~Chicago~~

8 12 $

$2.62 per

~~200 lbs of coal 1000 feet~~

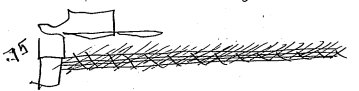
~~Gas~~ 2½ cts an hour

~~25~~ .128 per hour per lamp

200

$6.00 cts. cost Elec.

62 cts cost gas



Model

31 ooo | 5 000 000 | 161
31
190
156
40

715 | 5,000,000 | 6.9
4296
7100

$161

73,000 | 715,676 | 98
657
586
584
27

Coq/15 | 445,000 | 62
4286
1700

715 | 665,000 | 94
6335
3150

365
25
1725
630
8.025

6.96
8
$55.680 invested per burner

on hypothesis that five hours each day five feet an hour 8.025 ft. a year

Manchester Mr Hunter
Upper mill Salford Gas works

186 miles mains $161 capital & common
30,000 consumers
5,871 street public lamps

Product 715,676 M year

Capital $5,000,000 = £1,000,000
$6.90 per M
73,000 tons of coal used
9.800 cu. ft. per ton

Total Expenses £89,000 = $445,000
62 cts per M.

Income 133,000 665,000
94 cts per M.

as in another place
87 cts is said to be the price of gas the ~~cost~~ 94 cts must mean inclusive of coke
gas 20 candles per M

2000) 715,676
23.3

2ay 5 feet an hour

5 (23,333
365) 4666 (hours
365 12.8
1010
730
2800

715) 5000 (7

23.3
.87
1631
1864
20.27 / 1

Lalford

23 1/3 M for consumer a year
5 ft an hour
12.8 hours a day

$20.27 a year average gas bill

344) 1440 (41
1376
640

365) 4000 (12
365
750
365
344) 144 (

4.1 mills

.84 ft. a m
5 feet an hour

Paris

10 candles
344 street lamps 74.22
$1.44 an hour
4.1 mills per hour
10 candles on ground
4000 hours per summer
from sun rise to sunset
12 hours a day
five feet an hour
10 candles on ground

Z

1275) 45007 (35.6 cu ft = 1 cubit
38250
6757
5875
8820

31.317 cuft in one metre

250) 650 (2.6
500
1500

250) 1200 (4.8
1000
2000

24) 1657.50 (69
144
217
192
255

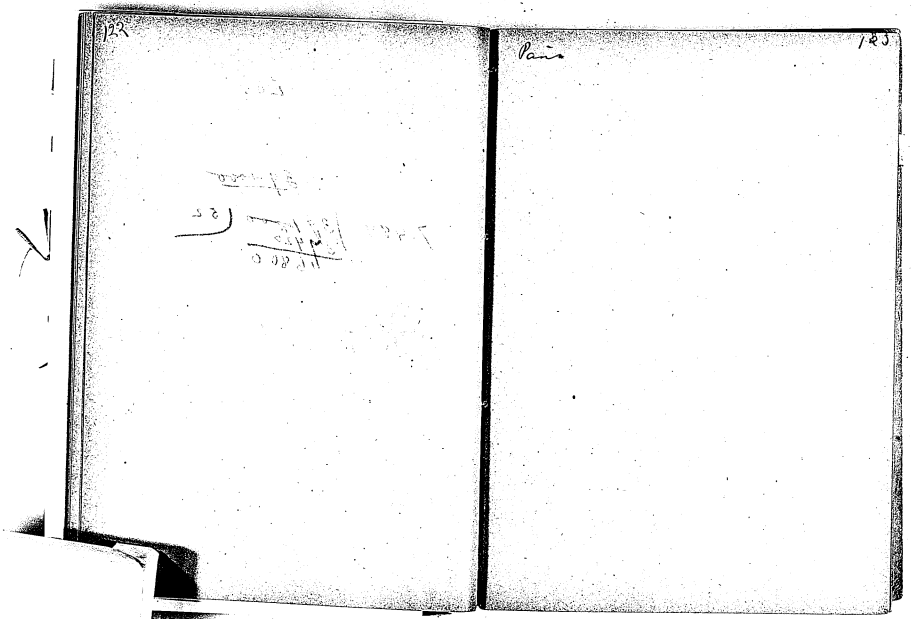
Paris

365) 7484 (20.5
730
1840

~~39.1000~~

7.484) 39.10000 (5.2
37.420
1.6800

250) 690 (2.76
500
1200



126

163 800
4
819,000

218.938

244) 218.0 (89
1950
2280

218) 819 (3.75
654
1650
1526
1240

15,645) 819,000 (52
78215
36770

15,645) 1,072,065 (68
93870
133360

218) 1,072 (4.9
872
2000

15,645) 219,577 (14
15645
6312
6258
5470

127

Rockdale

Capital account
£ 214.473 = $1,072,065

Value works $819.000

Gas made 244.738 M

Gas sold 218.938 M
11% lost by leakage

$3.75 value of property to M per year

$4.90 capital to M per year

15.645 consumers

About 14 M for consumer per year

40.283
5

15.267) 201415 (14
15267
48145

44000
5
220000

219.577) 220,000

Co. 20,215
5605
14610
5
83050

9685
8018
25.605
23.364

50.4175
23.308
27167
5
813.5835

219) 135.83 (62
1314
473

218.7) 107.2 (.49
876
1960
1962

Rochdale

$14 a year a consumer

$1.00 a M

Cost of gas 62 cts. per M

130

131

Dinder

292,000 M

4 a 2d = $1.04 per M

~~29~~ 26 candles

6.82) 18 90 000 (2 6 2 0 0 0
1364 5
4260 1310000
4092
1680

Bradford

The average of profits for eight year was 5.09 %

£ 262,000 capital

$ 1,310,000

New York

466
1 600
~~176~~ 170
4 000 1 000
2 500 900
5 000 750
18 000 2 720
4 000
270
19 536
2.720
22,256

2.000
1 200 320
1 000 625
1 000 700
1 000 1645
1 000
500
7 700

In New York city according to the par value of the stock July 16, 1879

$19.536,000 stock
2.720 000 Bonds
22 256 000 Bonds & Stock

Brooklyn

$ 7.700,000 Stock
$ 1.645 000 Bonds
$ 9,345, 000 Bonds & Stock

381) 1356 (3.56
1143
2130
1905
225 0

1.059.235
51.256
1110491

1110) 13565 (12.2
1110
2465
2220
2450
2220
2300

365) 3.814.671 (10,451
365
1646
1460
1867
1825
42

Germany

No Private works 262
Capital £2,713,117 = ℳ13,565,585
Annual production 3,814,671 M
Capital per M ℳ3.56
No. public lights 51,256
No. private lights 1,059,235 light.
ℳ 12.20 per ~~consumer~~ capitale
Average per day 10,451 M
Maximum in a day 16,559 M

138

7956 | 28.741 | 3.61
2385
4891
4776
1150

1.744 | 17440 | 95
82 | 1647
1830 | 970
915

139

Germany

Municipal works No. 220

Capital £ 5,748,425

$ 28,741,125

Gas produced

7.956,000 M

Capital per M$ 3.61

Public lights 86,481 — 5%
Private lights 1.744,713 — 95%

28.741.125
13.565.585
$ 42,296,710.

365) 7 956 000 (21779
730
656
365
2910
2555
3550

100 : 108 :: 60 : X
60
6480

100 : 108 :: 60 : Y
60
6480

Germany

1744000
86 481
1,830,481) 7,956,000 (4.4
7220
7360

4.40 cu ft. per lamp

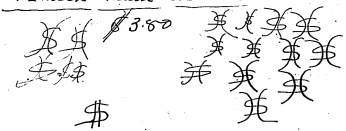
1,059,235
51,256
1,110,491

1,110,491) 3,814,1 (35
3330
5840

$1.80 a year for street lamps

£10 three light meter
12

£17 3.50 Meter
per light
12 inch main centre



£39.000,000
60
22
20
45
4000
8860

If the Edison can make
light, less than 62 cts
500 000 000 a thousand in
England

250 000 000

£4.00 a ton for coal

1000 H.P.
4000
2 Tons an hour

£8 for coal

10000
5
50000

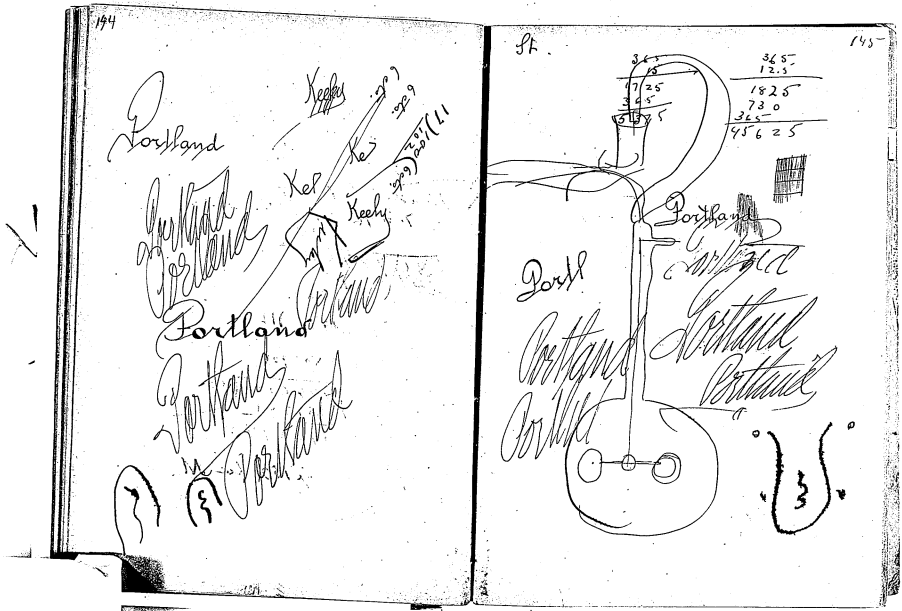
Madrid

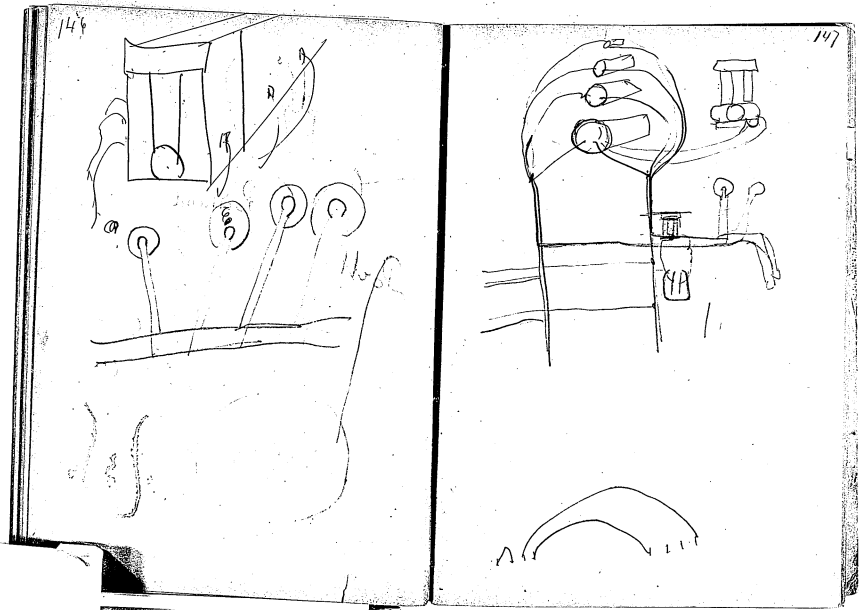
7.346.910 Lu meters
35
36734550
22046730
26,714,1850

257,741 M

Profits £80.923
5
257.741 | 404615 | 1.5
257741
1468740

Profits £150 Lu M

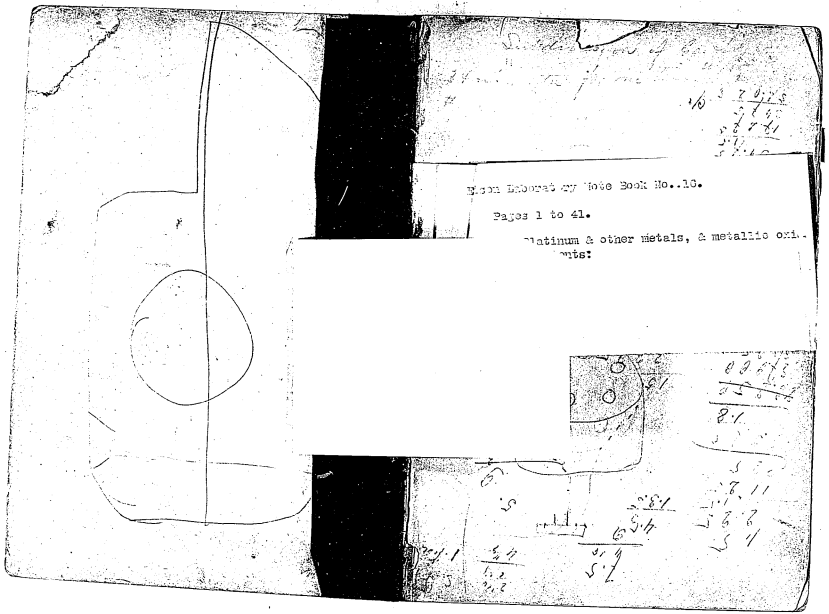

144
Portland
Keeley
145
Portland
Portland
Portland



Menlo Park Notebook #16 [N-79-01-21]

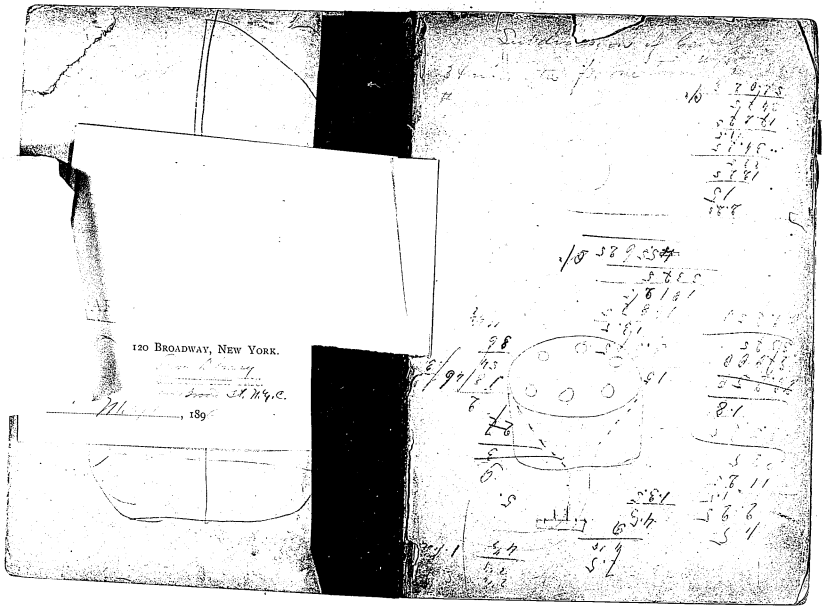
This notebook covers the period January 1879-March 1880. The entries are by Edison, Charles Batchelor, Francis Upton, John Kruesi, and Charles P. Edison. The name of Martin Force appears as a witness. All of the material relates to experiments on electric lighting and on the telephone. The electric light material includes notes and drawings of lamps; notes on filaments; notes, drawings, and calculations about generators; calculations relating to electric power distribution systems; notes by Batchelor on the cost and design of steam engines and boilers; and notes by Kruesi on the design of the central station for Menlo Park and the extension of the machine shop to house it. The telephone material includes notes and drawings by Batchelor and Charles Edison; notes by Batchelor on parts and prices for the telephone; and notes by Kruesi on making and packing the telephone receiver. The book contains 280 numbered pages.

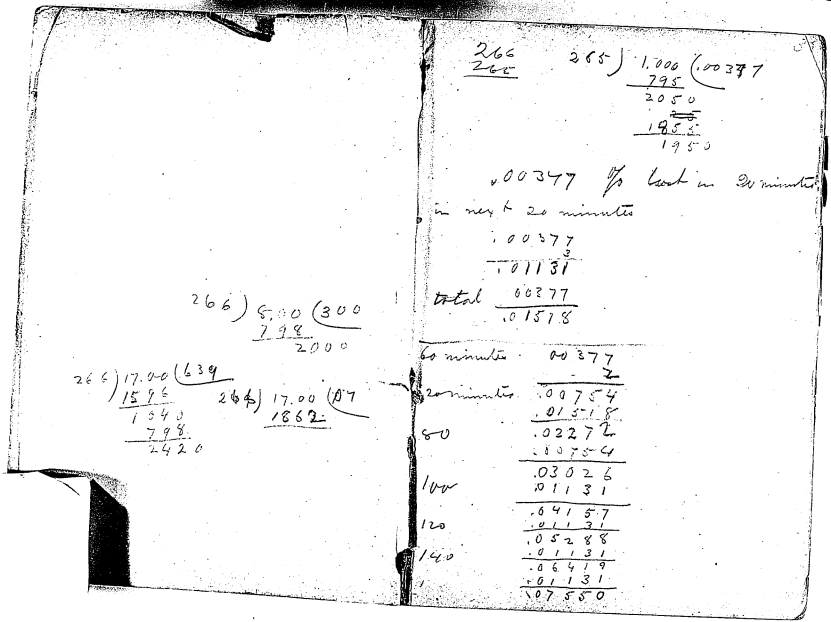
Blank pages not filmed: 236-237.


Edison Laboratory Note Book No..10.

Pages 1 to 41.

...latinum & other metals, & metallic oxi..
...nts:


120 Broadway, New York.
, 189



266
266 265) 1.000 (.00377
795
2050
1855
1950

.00377 % lost in 20 minutes
in next 20 minutes
.00377
.01131
total .00377
.01578

60 minutes .00377
20 minutes .00754
.01518
80 .02272
.00754
.03026
100 .01131
.04157
120 .01131
.05288
140 .01131
.06419
.01131
.07550

266) 5.00 (300
798
2000

266) 17.00 (639
1596
1940
1798
2420

266) 17.00 (107
1862

.0266) 1000 (.00375 94
798
2020
1862
1580
1330
2500
2394
1060

37594
3
11278 2
X4 150375
X2 75188
225564

.0132

266
249
17

266) 2350 (84
2128
1220

266) 17.00 (6
1596
1040

Minutes	% loss during	Total
20	.003	.003
40	.01	.015
60	.007	.022
80	.007	.030
100	.011	.041
120	.011	.052
140	.011	.063
160		
240		.084
260		.084

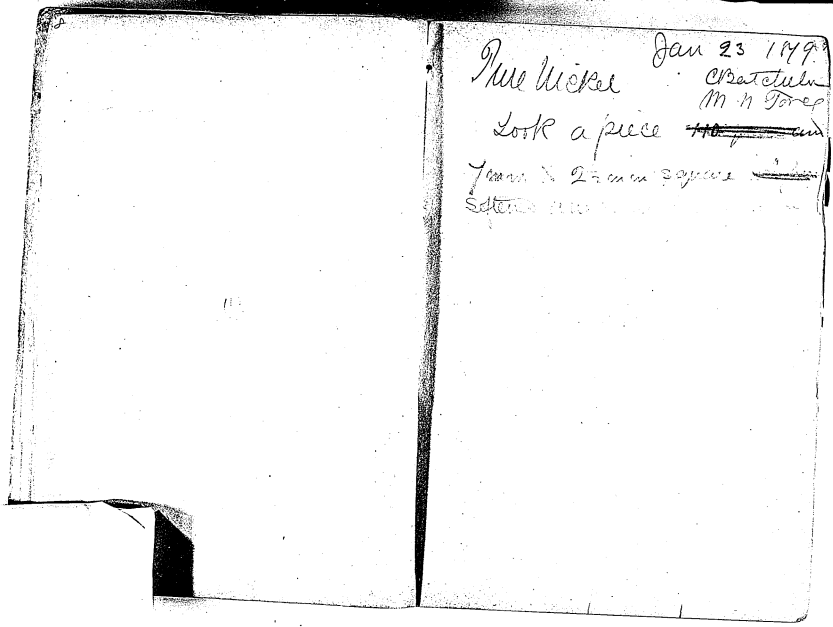
210
157
53
36
18

157
121
103

Pipeclay Jan 21st 1919

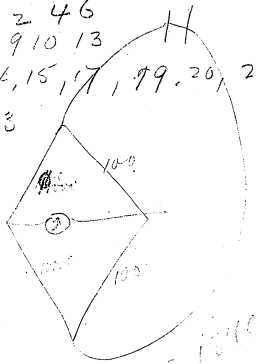
Charles Estelle
Marion N Forney.

Mass piece of pipe clay
1.75 X .937
dried for 48 hours and then
measured
1.655 X 1.875
put in oven at 320° Fahr and baked for
2 hours then measured


Jan 23 1799
Pull Wicket
Look a piece

10 Fuses

1. 2 4 6
7 9 10 13
14, 15, 17, 19, 20, 22 1
23



Group 25 [illegible]
Appl

Scheelite Ca. groups
Fuels Ox H [illegible]

27 Dolomite fuses

~~Mag~~ ~~Magnesium~~ Magnesium groups

~~28 Magnesite~~ fuses
Ca
Perhnite

Mg Magnesium groups
29 Magnesite Infusible

31 Steatite Soapstone fuses
32 Talc fuses
33 Tremolite fuses
34 Pyrope fuses
35 Serpentine fuses

Ath. . Jany 23 1871

Tag

36 Corundum Short crystals.

37 Diaspore fusible

38 Tschlorit "

39 Kyanite "

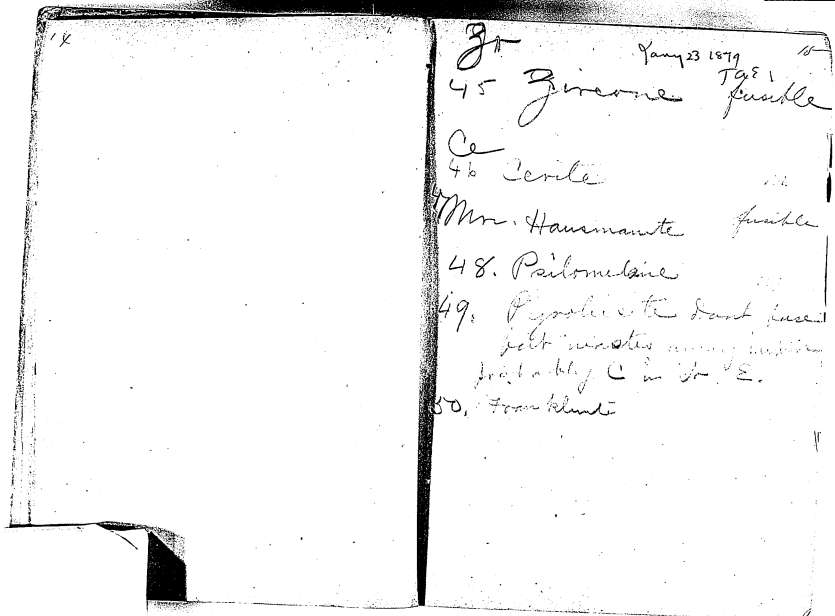
40 Kaolinite "

41 Pyrophyllite "

42 Talcoid "

43 Pargil "

44 Hydrotalcite fusible



Min January 23 1879

5-1 Rhodonite Jas.

5-2 ~~Le~~

5-2 Green Iron fusible

5-3 Iron pyrites " "

5-4 Magnetic Iron " "

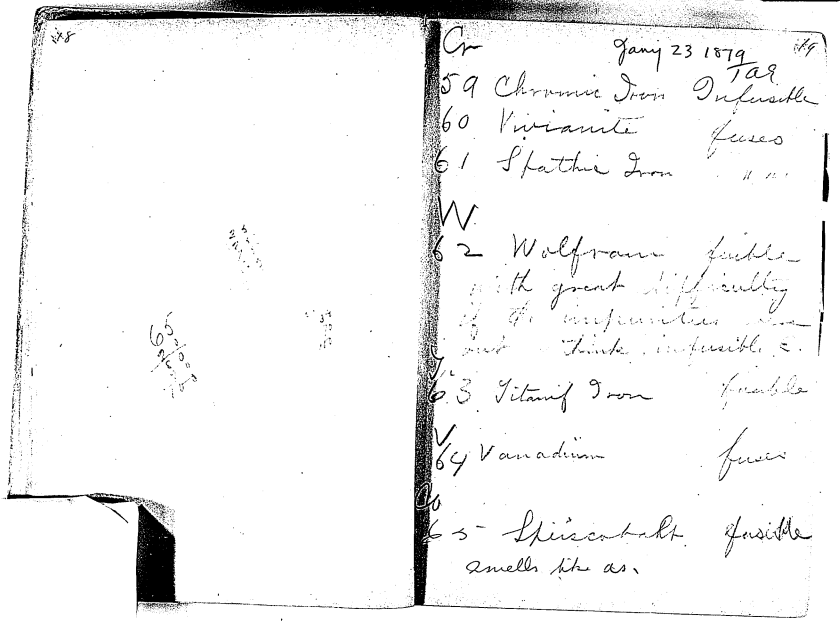
5-5 Hematite "

5-6 Limonite fusible

5-7 Spar Iron " "

5-8 " " Micaceous Impure

5-9



Jany 23 1879

Cy			Tag
66	Earthy Cl Ch		Franklin
Ni			
67	Copper Nickel		Franklin
68	Chathamite		
Bn			
69	Blende		"
Cd			
70	Blende	admixture	"
		Bisphuretted	
71	Zincite		Franklin
72	Calamine		"
73	Willemite		Franklin

Pt Jany 23 1879 Tats
74 Cerussite fuses with difficulty

75 ~~Pyrites~~ Phosphate fusible

76 Galena "

77 Molybdenite
fusible with difficulty fumes
a splendid light, does not
apparently fuse after many
min grind C.

78 Tin stone

79 Tin pyrites

144 0008
6
864

12
95

Bi

Jany 23 1879

80 Nat. Bismuth Tar
fusible, malleable after
fusion

81 Tellurit

82 Platinbalmine

Cu.

83 Cu fusible

84 " "

85 " "

86 Cu fusible "

87 Cuprum "

88 Argentu "

Jany 23 1879

89 Tin Lodes

90 Chyanvale tin ores

91 Cinnabar

combined with do

92 Mg.

93 Gold tin ores

94 Pt "

95 Molybdenite tin ores

96 do tin ores

97

98

99 B Tuesday January 23 1879 29
The Tunnels

10-0 Quartz

5 M.C. cold hot
" "

29 M.C. cold hot
" "

8 M.C. cold hot

11 M.C. Cold hot

12 M.C. Cold hot

25 Nc. Cold last night 23 1879 31

18 Nly. Jae

21 Nly.

22 Ny. in extremely small.

36 Ny.

82 Nc cold very little heated given off by the coals. For investigation.

80 Nly.

59 Chronic D[illegible] Jan 23 1879
slight C when cold better Feb 5
when Lot from carriage
stands a great heat

58. Ng [illegible]
conduction

57 Ng.

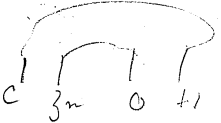
62 Ng.

74 Ng

D = 43° Jan 23 1879
42°5 Daily

46°5 to bring to
the same as No. 1 when
[illegible] vacuum

5-1°0



1,15) 2.74 (2.3
2 30
1 1 0

Reddish yellow with air
22°

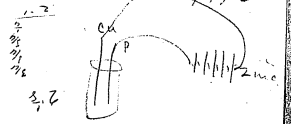
Yellow in vac
23 1879
Tait

Dull red 17°

Volatilization 49° 1,15

Without 70° 2.74

2,74 1.15



38

10.5 in

~~.0001~~

3.141592

700

10.5
.07
.735

3.14159
.735
157079 5
942477
03

39

10.5 in

~~.03~~
.020

3.1415
.02
.06 2830
10.5

3.1415

.120

3.14
.12
.3768
~~.65~~ .65
1850

.65

1/4

222
.240 5

72 car

1/4 inches gave about 18 candles

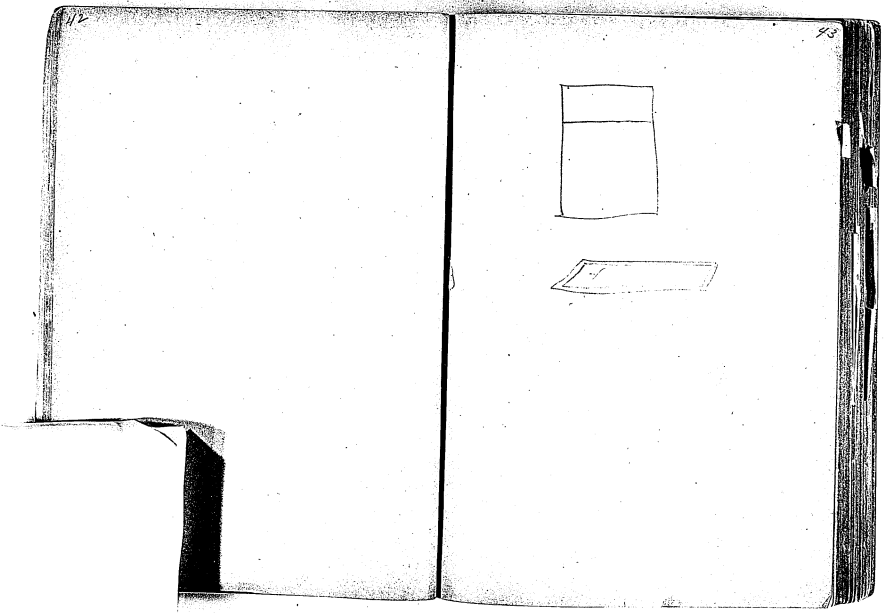
~~60~~

70 candles per sq. in.

An explanation of the changes wh. occur in Pt. may be the following. The Pt absorbs an enormous amount of H gas which is given off at high temperatures

Feby 4 1879

T A E
Chief Instructor



3 Chalk
9 gr Acetate Liq.
1/2 Fluid oz Carbonic Soda.

Chalk for Effervescs.

New Remedies, 1871

Clive Balkwill

take 6 oz chalk in mortar and add to it 18 grains of tartaric Mucilage. grind the up til dry then add 1 fluid oz [illegible] Salicylate Carbonic Soda. when [illegible] well ground

.92 Ohms Feby 26 1879
Jack

20 feet .61 Ohms

5 ft to turn

5 | .61
.122 Ohms in 1 turn
25 turns
610
305
2 | 5.125

4 | .61
.152 Ohms in 1 turn
25
760
304
2 | 3.800 Ohms
1.900 Ohms

.018
.018
144
18
.000324

1.9

6 4 8 | 125
4
24
24
0

125 00
62

26
26
156
52
676

120

.025
.028

.624

60.5 | 1256 2.06
1210
4000

50

8 × 12
3 × 12
144 ft
on track

.01	5 ft
.02	10 ft
.02	10 ft
.05	25 ft
.10	50 ft
.20	100 ft
.12	60 ft
.65	250 ft
1.10	

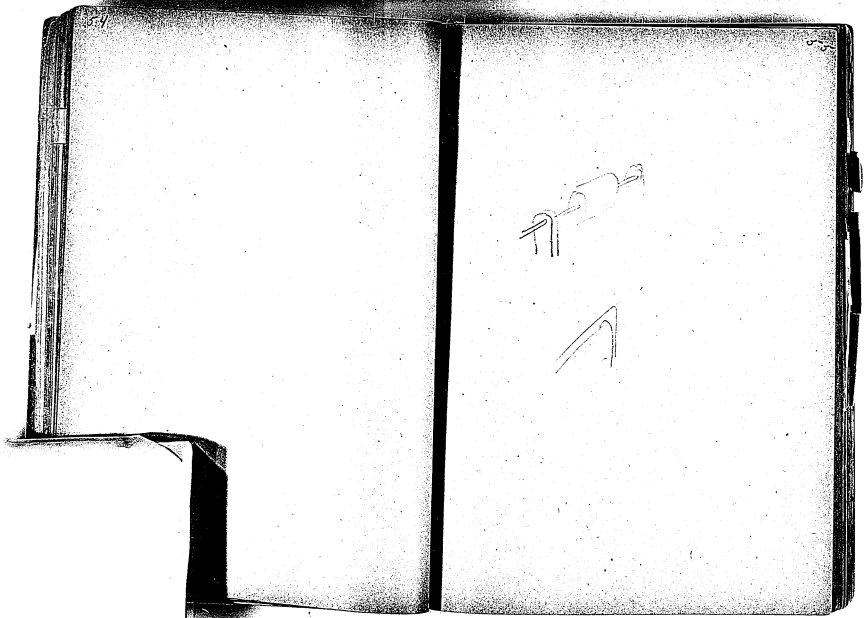
10 lbs of #15 wire
2 lbs of #18 wire
1 lb of #23 wire

52

53

.01	5 ft	No. 15	
.02	10 ft		
.02	10 ft		10 lbs
.05	25 ft		
.10	50 ft		
.10	50 ft		
.20	100 ft		
.50	165 ft	No. 18	2 lbs
1.00	No 20		10 lbs
1.00	No 118		
2.00	No 23		1 lb.
5.00	No 27		1 lb.
10.00	No 30		1 lb.
10.00			2 lbs.
20.00			

10 lbs No 15
2 lbs No 18
1 lb No 23
1 lb No 27
2 lbs No 30



L.L.V. Sewell.

Feby 26 1879

c/Mch 5th 1879 Tec'g

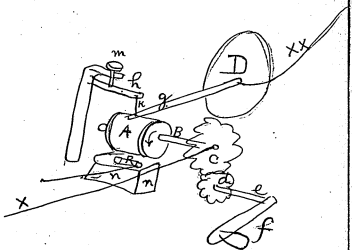
A.W.S. patent is to be taken out in the
for U.S. and which I furnish you
a model. I also furnish you a
second model to go with the
Canadian patent.

This is the C.W.S. specification.

The scope of patentee's invention
is to transmit and receive
sounds telegraphically at a distance
with great power and exactness
loss of volume.

~~The principle of the~~
~~The invention consists~~

The peculiar action upon which ~~the invention~~ the invention is based was patented by me (original Electromagnetic) ~~of~~ Number ~~—~~, An application of the action to telephony was also patented ~~applied for~~ (1878) This is the patent where a band of paper was used) — The present application consists more particularly in devices which make the invention perfectly practicable for use in Commercial and infinitely more reliable & effective



A is a cylinder of ~~el. H~~ Compressed Chalk soaked in an Electrolyte the Solution such as a Common alkali Hot Urinary Excrement or Conductor of Electricity

I will mention that any finely
divided non conducting material
or porous body having capillary
pores (which has no chemical action
upon the absorbed solution
may be used -

This cylinder is secured to a
shaft B ~~and~~ & the cylinder is
by the operator by means of
rotated ~~by~~ the toothed
wheels c d, and
shaft & handle e f
or worm & pinion or may be
with pinion of a
particularized and, the
~~of the~~
Clock work or analagous
motor made to replace

the Hand of the operator.

Resting upon the cylinder A is a flat spring g connected to the disc plunger D. this spring is pressed upon the check with a pressure of several pounds by means of the wire K & spring h. the screw M serving to increase or decrease the amount of pressure - The line wire XX is connected to the spring g while the Earth wire is connected

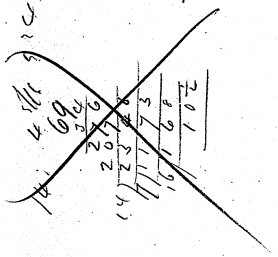
to the shaft on which the
Cylinder A is secured.
Now the cylinder C
rotated in the direction
shown by the arrow 2 no
Current passes the normal
friction of the spring g
upon the surface of the
Cylinder A will be very
great and the spring
will be carried forward
in the direction of the
rotation of the cylinder
thus pushing inwardly

68.

69.

4 5/16 - 14.

34.



The diaphragm D. if now a current passes whose direction is such that Hydrogen will be produced upon the surface of the ~~Piece~~ piece g in contact with the Chalk. the friction will be reduced to an Extent proportional to the strength of the current ~~and the~~ since the diaphragm will regain its natural position and continue there as long

as the current passes as the friction between the spring a & A is too small to produce sufficient traction ~~[illegible]~~ if now the current ceases the normal friction at once obtains. The traction increases & the diaphragm is instantly pulled outwardly if now a current in the opposite direction is transmitted the effect is ~~[illegible]~~ scarcely noticeable as the evolution of

Oxygen in the surface of the spring q. does not except with a ~~few~~ few ~~to~~ saturations decrease the friction like Hydrogen but on the contrary q. gas tends to increase the normal friction, hence I allow a constant current to circulate in the line and am thus enabled to ~~use~~ utilize the opposite wave by causing them to weaken the constant

Current which is always
in a direction to evolve
Hydrogen on the surface
of the spinning J.
for instance if the constant
Current was upon the line
the only ~~one of the~~ waves
in one direction would
produce an effect
whereas if a constant current
is circulating one of
the waves" added to that
~~Strength~~ of the current

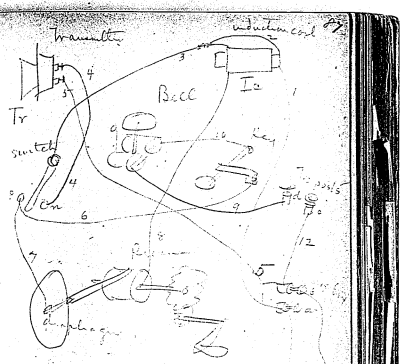
and the other wave
neutralizes or nearly neutralizes
the Constant Current
hence the tendency of
1 wave is to produce a
lessening of fraction of
say 5 units which is
to that produced by
the Constant Current
say 5 together give
10 units if now an
opposite Current is
sent it neutralizes
the Constant Current

we have the normal
friction of the cylinder
whereas if no Constant
Current was used one
Current would lessen the
friction by 5 units & the
opposite Current would
perform no work.

N is a receptacle
Containing water.
resting in the water
is a roller R composed
of any flexible absorbent
substance such as

Sponge or felt,
The lever to which the
roller is attached by,
which the roller may
be brought in contact
with the cylinder A.
Extend through the box
to the outside, the
object of this device
is to supply the cylinder
with a water heat by
Evaporation & made of
a Conductor to the
Electric Current

In practice when all the
apparatus is enclosed in a
Cast iron case the loss
in evaporation is very small
and if the roller be held
against the cylinder =
if the cylinder be raised
three or four times the
Clock work takes up
sufficient motion so that
it will perform its functions
for a week or more without
again winding it =



The Connections are as follows

Tr is the Receiver Circuit Telephone
transmitter placed in a
local circuit with the
induction Coil Ic with

local battery of the operation
of the switch lever upon
the button n. then the current
proceeds from the Local
battery X X via wire 1
to the [illegible] in the ordinary
coil thence via wire 2 to
3 thence to the switch lever
thence via wire 4 through
the Carbon transmitter thence
by wire 5 to the post
6. thence to the battery
The sonorous waves of the
Voice are translated into
Electric waves of a precisely
analogous character

in the second day Cont of the
Induction I. in the
well known manner;
The Commotion of the mare
here is to follow the line
from the distant station
Enters at the point d.
thence via. w.n.w. 9 to the
Pole thence via w.n.w. 10 to
the Key Corner thence
via. w.n.w. 6. to the point
p ~~th~~ of the worlds
thence via w.n.w. 4 to
the spring 9 of the
Meridian thence thro'

the main chalk to wm
8, to 4 through the
secondary call thence
via wm 3 to the Switch
from which it will be remarked
by mi ii thence via wm 4
through the Communication to
wm 5- thence to post
6 & thence via wm 12
to the post e which is
Connected to the earth.
I will mention that either
of the posts d e may be
Connected to the ground
or line, It will be remarked
that the main line runs
through the Communication

which is communicated to the
Lead Cutting hence a
portion of the Current leaks
into the main line & it
is this portion which then
leaks into the line that
serves as a Constant
Current for short lines
but if the line be to
long or has too great a
resistance the small
leakage Current is
so weakened as to be
insufficient to produce
a loosening of friction

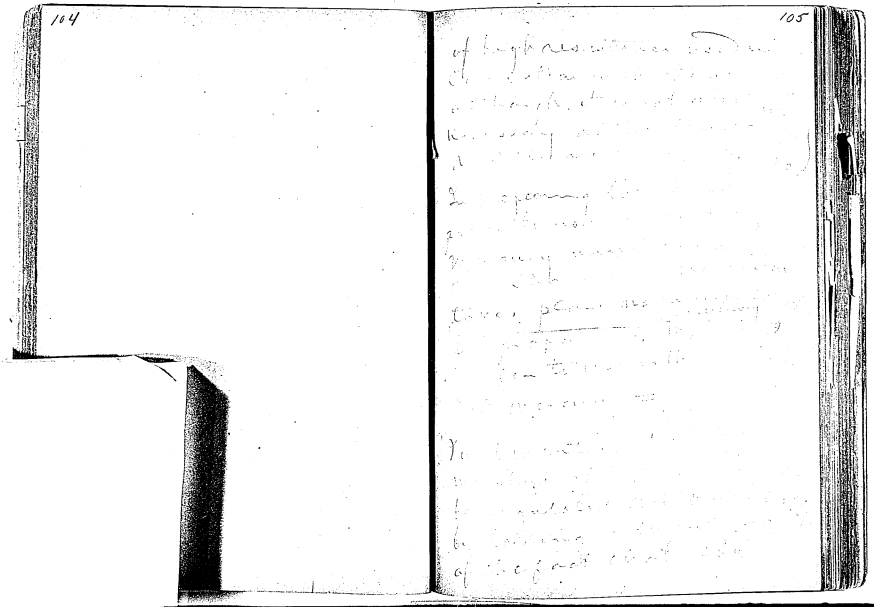
between the spring 9 & the
Chalk Lever 9 ~~subsidy~~ 1
or more cells ~~in~~ in the
main line =
~~Switch~~ ~~board~~ ~~is~~ ~~in~~ ~~this~~ ~~position~~ ~~(1st)~~ ~~the~~ ~~lever~~ ~~in~~ ~~Central~~ ~~with~~ ~~a~~ ~~transmitting~~ ~~&~~ ~~receiving~~ ~~can~~ ~~go~~ ~~on~~ ~~simultaneously~~ ~~by~~ ~~turning~~ ~~the~~ ~~switch~~ ~~lever~~ ~~to~~ ~~the~~ ~~point~~ ~~p~~.
The ~~Telephones~~ apparatus
is disconnected & the
Call Bell apparatus

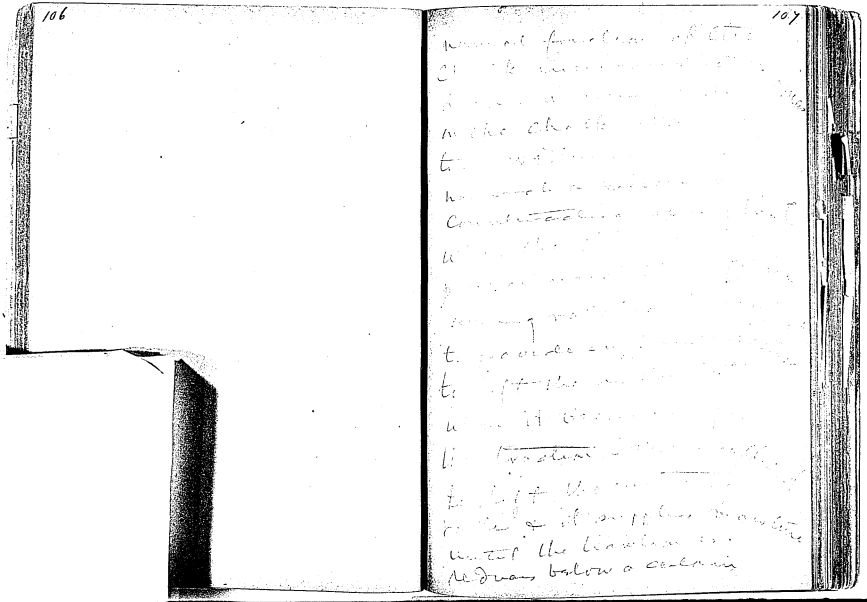
become operative, the line
enters at the post d
passes through the bell via
wire 9. thence via 10 to
Key. thence via 6. to p.
thence via lever to wire 3.
thence via 2 through the
primary coil 4 via 1 to
local battery through chest
to post 6 thence via 12
to post c to earth, by
depressing the key the
circuit is opened & closed
& the two local batteries
at each end of the

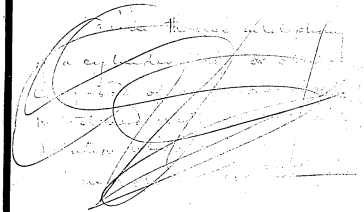
line Galvanic operation &
using the Bell.

Inillumentum, that the two receivers herein described & the two transmitters may all be connected in one fixed & operated without the aid of undulatory Coils but the receivers are not equal but at from the use of the Coils, also that the Receivers will act as transmitters by reason of the fact that when the opening of Chalk as at rest the resistance of the whole

is generally about 2500
ohms & this resistance is
reduced momentarily to
2 or 300 ohms by the slight
movement of setting the
Chalk or the spring ~~the~~
~~sheet~~ hence the movement
of the diaphragm D by the
voice produces the same
result or nearly so as the
Carbon transmitter, and
advantage ~~~~ of course
is to be taken of this fact
the surface of the
spring g. should be adjusted
to increase the effect
and an induction coil
having a primary coil



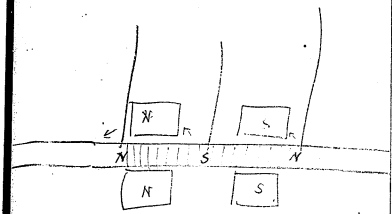


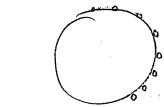


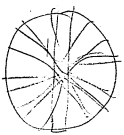
with an Electrolyte — a solution
with a ~~n~~ Electrode Connected
to a diaphragm plate or other
body Capable of rendering
the motion produced by Electricity
~~en~~ audible —

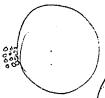
3rd In combination with
a ~~n~~ solid expanded [illegible]
in a closed receptacle [illegible]
of a ~~n~~ material [illegible]
a equipment for supply of
water out as [illegible]

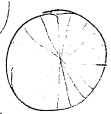
4



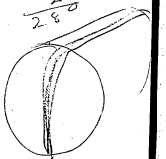


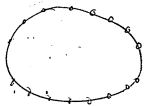


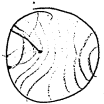


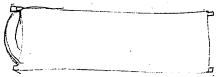


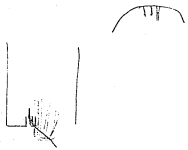
14
20
28











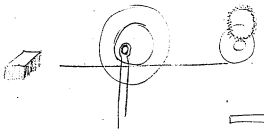
6 — 18·84

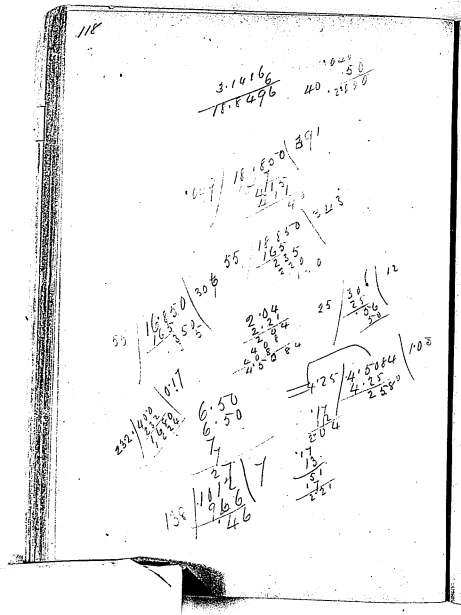
5'

5 turns wants equal ·25 ℔ Hour ·80

12=50 inch

11





New shell for Order 58

18 wire in 25 coils

18 wire = ·049 = 232·3 feet per chain

Per 6" chain = 18·85 -

~~[illegible]~~

18 wire & silk = ·055 = 343 wires in circumf

18·85 − 2·(·40 for diameter) = 16·85

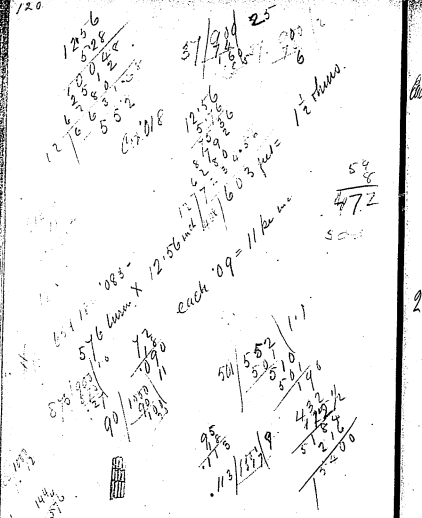
16·85 ÷ ·055 = 306 wires

306 wires ÷ 25 = 12 wires to each coil : 6 on top and 6 on bottom or 6 whole turns

6 whole turns would be 27 inch × 6 = 162 × 3 layer = 486 inch = 40·5 feet = ·17 ohms

Resistance 8 ring = $\frac{(12 \times \cdot 17) \times (13 \times \cdot 17)}{(12 \times \cdot 17) + (13 + \cdot 17)} = \frac{2 \cdot 04 \times 221}{2 \cdot 04 + 2 \cdot 21}$

$\frac{4 \cdot 5064}{4 \cdot 25}$ = about 1 ohm



Wire for Field magnets of Order 58

Coil 2 feet long = 4 feet long of 4" diameter

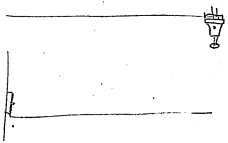
Resist. required 1 ohm

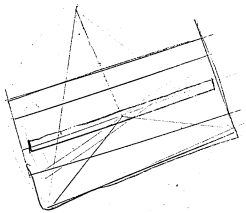
1 layer of No 16 cotton Cov. = 72.34 inch = 6.13 feet
= 1½ ohm (wire not dia)

1 layer of No 18 cot cov = (11 turns per inch) = 48 inch
× 11 = 528 turns of 12.56 inch each =
528 × 12.56 = 6631 inch = 552 feet = 1.1 ohm

2 layers @ 13 = (9 per inch) 9 per inch
4 × 9 = 432 turns × 12.56 inch =
5.50 m = 450 feet + 1st layer 450 feet =
= 900 feet = 1.01 ohm

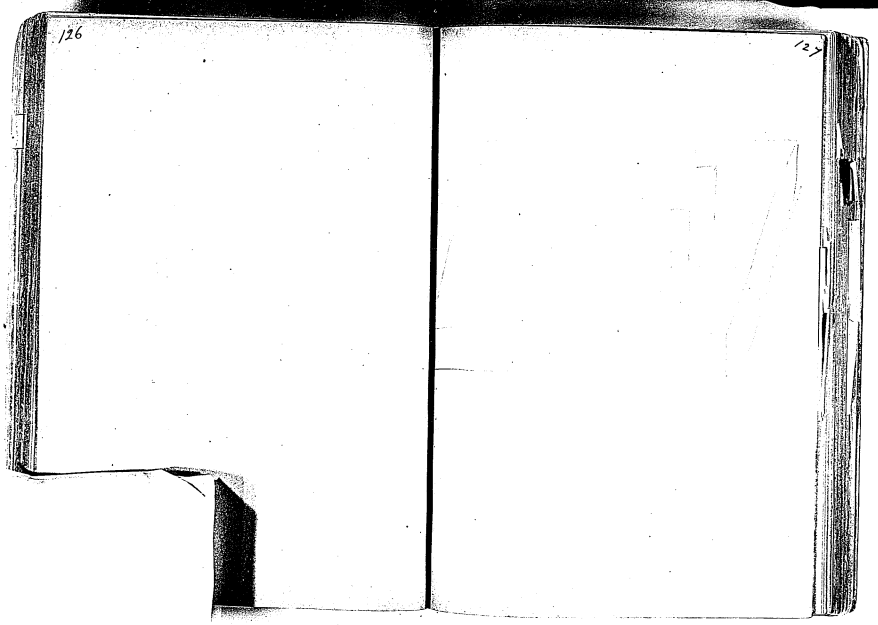
Order for this (37 feet per lb)
3 lbs of No 13 cotton Cov.
wire the diameter of this
wire bare must be .095
95 thousandth





90

The long magnets require 643 ft
of No 11 = .120 wire each =
0.461 Ohm = 56 lbs.


126
127

Plan No. 1

Plan of Lot No. 1 in Block No. 1 of Subdivision of Block No. 1 of Subdivision of Block No. 1 of Subdivision of

130

131

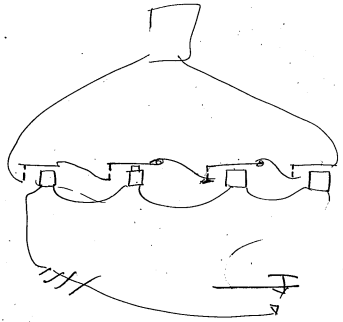
B

D 1/4

B

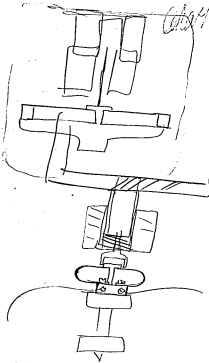
D. W. Patchin

Gramme



April 4 1879
T W K

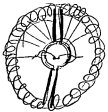
April 4 1879
T W K
Gramme Machine



April 4 '874

Tea

Robertson

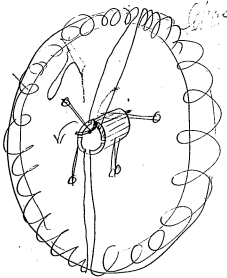


136

April 4
1879

137

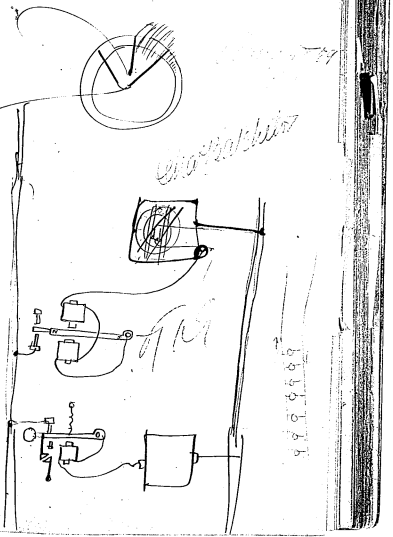
April 2 1879



138

105

139



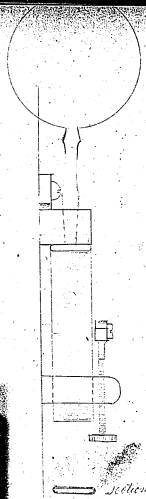
B
B
B
B
Stelle
Mühle
Mühle
Mühle
Mühle

142

143

Chaussiette

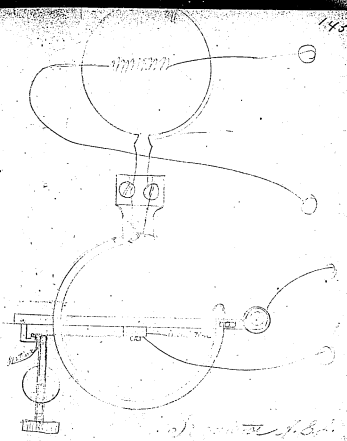
144



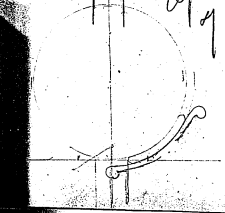
Section of Fuse

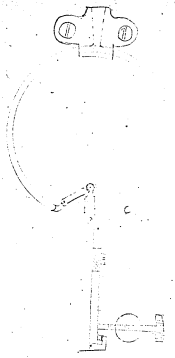
April 7/1877

145



T. W. E.
Ultra-practicable



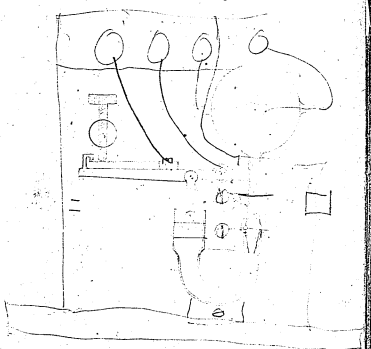


148

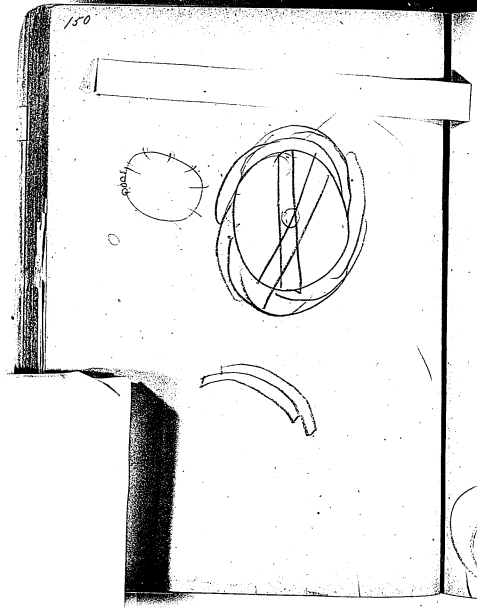
149

Regulators of S.A. No 2 Order No 112

Charging Selector

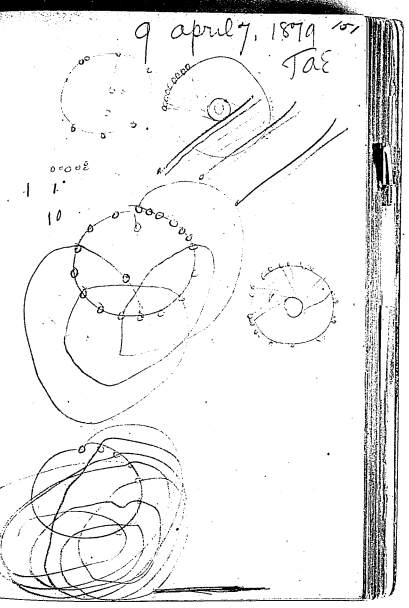


TNR



9 april, 1879 151

TAE



7.6 Gravitation

April 3
14:52

60 mins 60 s = 14,52

HP
1000

250 machines 1 hr

50
50
2500
37

15

45

750
45-
375-0
300
12) 3375-0 (2812
24
97
96
15-
12
30
24

2812.

520.

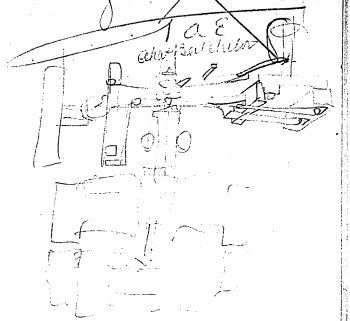
30

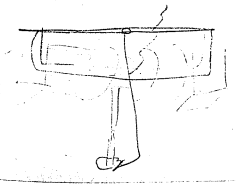
Paula

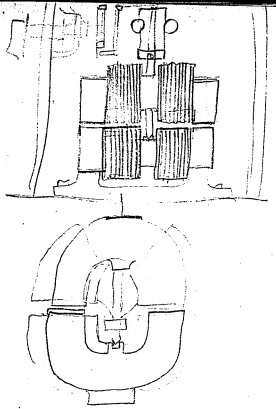
Rec R

1	—	1·74	
2	—	1·11	
3	—	1·04	
4	—	·96	
5	—	·86	
6	—	·74	
7	—	·61	
8	—	·45	
9	—	·41	
10	—	·41	
11	—	·41	
12	—	·45	
13	—	·66	
14	—	·72	
15	—	·84	
16	—	·93	
17	—	1·02	
18	—	1·04	
19	—	1·13	
20	—	1·17	
21	—	1·16	
22	—	1·19	
23	—	1·16	
24	—	1·12	
25	—	1·07	
26	—	1·00	
27	—	·92	
28	—	·85	
29	—	·78	
30	—	·74	
31	—	·74	
32	—	·78	
33	—	·84	
34	—	·91	
35	—	·97	
36	—	1·01	
37	—	1·04	
38	—	1·04	
39	—	1·04	
40	—	1·04	

May 9 1879

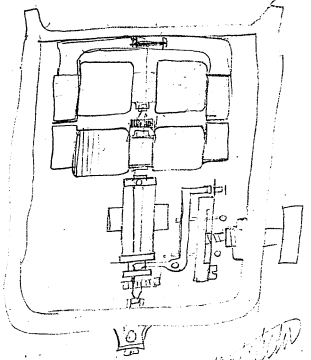


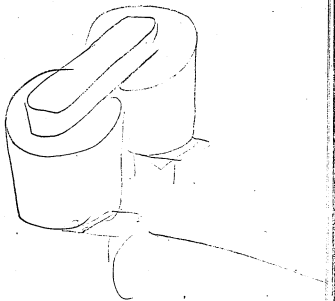




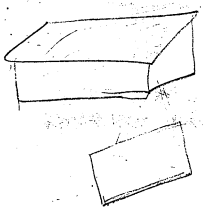
May 9 1879

May 9 1849





166

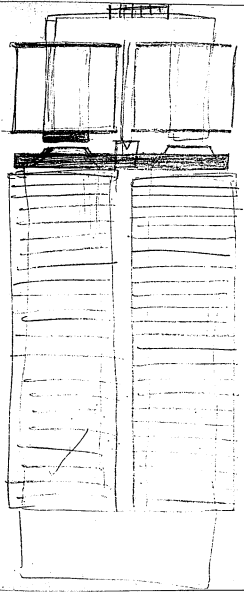


850,

300 | 50000 D
166,666
20
333,320

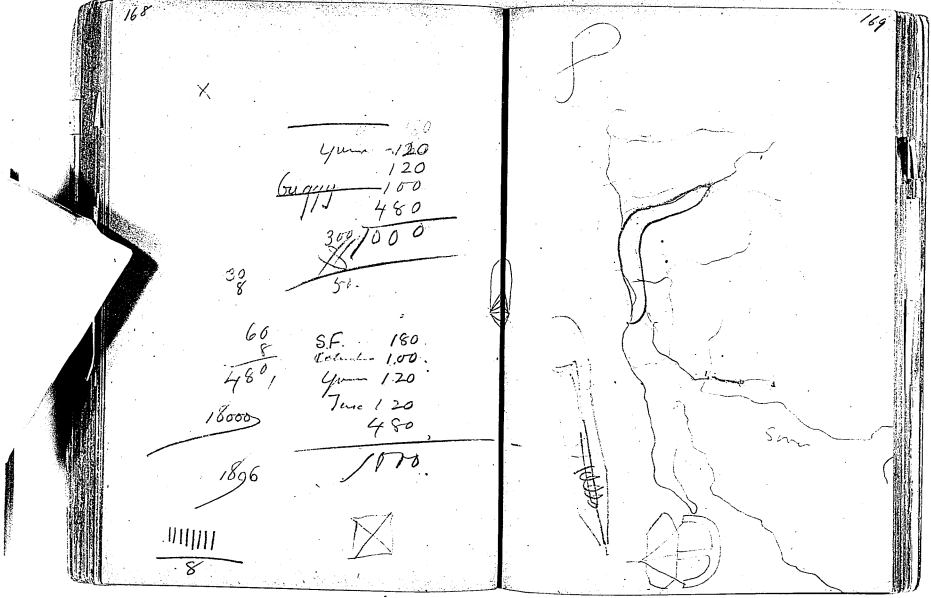
300,

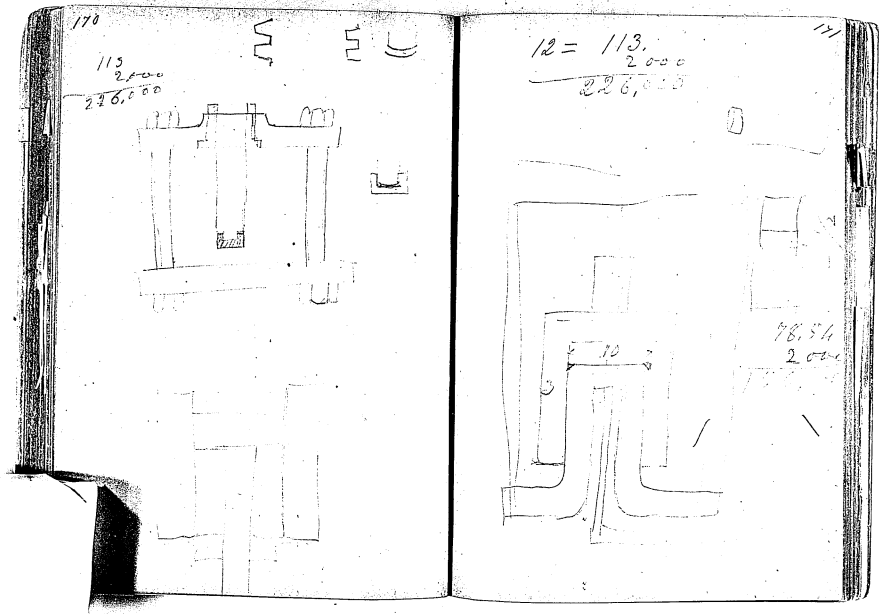
167



168

169


Yuma 120
120
Gila 100
480
300 1000
30 8 St.
60 8 S.F. 180
480 Yuma 120
Tucs 120
18000 480
1896 1080.
8
Sonora


170
113
2000
226,000
12 = 113.
2000
226,000
171
76,54
2000

172

20 1/2

1	100
2	50
4	25
8	12½

12½

25, 50

173

20.5.82 12

1

25.

Dollars	Lights
132 00	110
119 90	110
107 80	110
95 70	110
83 60	110
71 50	110
59 40	
47 30	
35 20	
23 10	
11 00	
786 50	

110 wires

to 340 feet from station

1100.

2350
7150
9500

132 00
119 90
251 90

36

37
18 ½
55

55
25
275
110
1375
2
27.50. ¼ mile

10

7

110
10
1100

$\frac{1}{4}$ miles 12 $\frac{1}{2}$ wire, 10 lights each Lamp

1250	1500
1240	1490
1230	1480
1220	1470
1210	1460
1200	1450
1190	1440
1180	1430
1170	1420
1160	1410
1150	1400,
23200	
1140	1390
1130	1380
1120	1370
1110	1360
1100	1350
1090	1340
1080	1330
1070	1320
1060	1310
1050	1300
1040	1290
11990	
1030	1280
1020	1270
1010	1260
1000	1250
990	1240
980	1230
970	1220
960	1210
950	1200
940	1190
930	1180
10740	

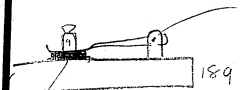
110 Lights

132,850

110 Lights

119,190

107.80



189
95
284 $-\frac{1}{4}$ ohm

1 cent per foot

.10 .10

Last span 10 150 ft Lamps labled R 10 to the cond. A 125
78 180. at 2.5c 12.50

27 127

780
780
8580

156, 20,
5
781

920	1170
910	1160
900	1150
890	1140
880	1130
870	1120
860	1110
850	1100
840	1090
830	1080
820	1070
9570	

9570

810	1060
800	1050
790	1040
780	1030
770	1020
760	1010
750	1000
740	990
730	980
720	970
710	960
8360	

8360

700	950
690	940
680	930
670	920
660	910
650	900
640	890
630	880
620	870
610	860
600	850
7150	

7150

590	840
580	830
570	820
560	810
550	800
540	790
530	780
520	770
510	760
500	750
490	740
5940	

7150
1210
5760

70

540
to 2310
440

70
70
180
110,

5
500
to
440

440
to
340.

740
to
640 = 4750

2710
1210
1500

5750
2100
4750

640
to
540 = 3520

4750
1210
3540

3520
1210
2310

George

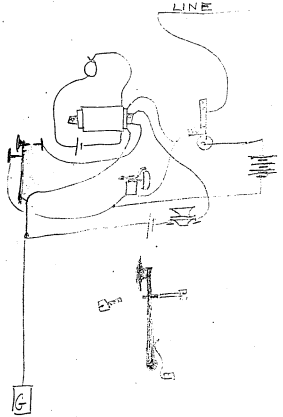
Nov 17th 1879

Take a large [illegible]
[illegible] Carbon [illegible]
Powder the coke about
size of pea [illegible]
put up about 4 cells thus

Take a [illegible]
time dust coke
using a solution of Caustic

[illegible]

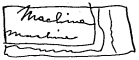
Do the [illegible]
from paraffin


LINE
EARTH
G

184

~~Armature Speed of~~
~~Steam Engine~~ 105
~~Belt~~

Edison Dynamo
First 25-0
Second Speed 65-6½
Third " 20

Edison Dynamo 

185

Fall in E. M. F.
1 lamp 100 Ohms
Conductor 1 Ohm Machine ½ Ohm

~~1.5 100~~ ~~100~~
.1.5 101.5
5-0

.50 25
51.5 26.5

12.5
14

186

1 — 100 / 101.5

2 — 50 / 51.5

3 — 25 / 26.5 — 33.33 / 34.83

4 — 25 / 26.5

5 — 20 / 21.5

2.00624		
2.0064		
1.9936	.985	
2		
1.9872	.971	985²
2		
1.9744	.942	
1.6996		
1.7118		
1.9872	.971	
1.9744	.943	971²
1.9488	.889	
1.5228		
1.5420		
1.9808	.957	
1.9616	.915	957²
1.9232	.838	
1.3979		
1.4232		
1.9744	.943	
1.9494	.890	943²
1.8788	.792	
1.3010		
1.3324		
1.9686	.930	
1.9372	.869	930²
1.8788	.756	

6 — 16.66 / 18.16

7 — 14.28 / 15.78

8 — 12.5 / 14.

9 — 11.11 / 12.61

10 — 10 / 11.5

1.2206		
1.2588		
1.9628	.918	
1.9256	.843	
1.8512	.694	
1.1547		
1.1982		
1.9565	.905	
1.9138	.818	
1.8260	.670	
1.0969		
1.1761		
1.9508	.893	
1.9016	.797	
1.8032	.635	
1.0454		
1.1008		
1.9446	.880	
1.8892	.775	
1.7784	.600	
1.		
1.1607		
1.9393	.870	
1.8786	.756	
1.7572	.572	

11 [illegible]
7.09
10.59

.9586
.0248
1.9338 .859
1.8676 .721
1.7352 .543

12 [illegible]
8.335
9.839

.9208
.9927
1.8281 .847
1.8562 .718
1.7124 .516

13 [illegible]
1.6923
9.1923

.8861
.9635
1.9226 .837
1.8452 .700
1.6904 .491

14 [illegible]
1.14
8.64

.8537
.9365
1.9172 .826
1.8347 .683
1.6688 .466

15 [illegible]
6.66
8.16

.8237
.9120
1.9117 .816
1.8234 .666
1.6468 .443

16 [illegible]
6.25
7.75

.7959
.8893
1.9066 .806
1.8132 .650
1.6264 .423

17 [illegible]
5.8823
7.3823

.7696
[illegible]
.8683
[illegible]
1.9016 .797
1.8032 .636
1.6064 .404

18 [illegible]
5.585
7.055

.7447
.8485
1.8962 .787
1.7924 .620
1.5848 .384

19 [illegible]
5.263
6.763

.7213
.8301
1.8912 .778
1.7824 .606
1.5648 .367

20 [illegible]
5
6.5

.6990
.8129
1.8801 .769
1.7722 .592
1.5444 .350

25

4.
5.5

.727
.529
.280

.6021
.7404
1.8617
1.7234
1.4468

30

3.333
4.833

.690
.476
.226

.5228
.6442
1.8386
1.6772
1.3544

15) 2000 (133
15
50
45
5-0

15.4323

.30

3.3010
1.1884
2.1126

192

100 Ohm lamp 1 Ohm conductor in machine

100/107 = 21

		2.0043
	.990	T.9957
.982	.980	T.9914
	.961	T.9828

2 50/51 = 1.6990

		1.7076
	.980	T.9914
	.961	T.9828
	.924	T.9656

3 33.33/34.33 = 1.5228

		1.5307
	.971	T.9871
	.942	T.9742
.941	.886	T.9484

193

4 25/26 = 1.3979

		1.4150
	.961	T.9829
.954	.924	T.9658
	.854	T.9316

5 20/21 = 1.3010

		1.3222
	.952	T.9788
.907	.907	T.9576
	.823	T.9152

6 16.66/17.66 = 1.2216

		1.2471
	.993	T.9745
	.889	T.9490
	.791	T.8980

7

14.28 / 15.28 = 1.1547

.937 · 1.1831 = T.9716

.877 · 1.9432 = T.8864

.770 · T.8864

8

12.5 / 13.5 = 1.0969

.926 · 1.1307 = T.9666

.857 · T.8572 = T.9332

.735 · T.8664

9

11.11 / 12.11 = 1.0454

.917 · 1.0432 = T.9622

.840 · T.9244

.706 · T.8488

10

10 / 11 = 1.

.909 · 1.0414 = T.9586

.826 · .830 · T.9192

.689 · T.8384

11

9.09 / 10.09 = 0.9586

.901 · 1.0641 = T.9545

.811 · T.9090

.653 · T.8160

12

8.3333 / ~~5.8823~~ / ~~2.4503~~ / 9.3333 = .8928

.890 · .9702 = T.9496

.795 · .793 · T.8992

.629 · T.7984

13 7.6923 / 8.6823 = .8861

.885 × .9392 = T.9469

.783 × T.89388 = T.7876

14 7.14 / 8.14 = .8537

.877 × .9106 = T.9431

.769 × T.8862 = T.7724

15 6.66 / 7.66 = .8237

.870 × .8842 = T.9395

.757 × T.8790 = T.7580

16 6.725 / 7.25 = .7459

.862 × .8603 = T.9356

.743 × T.8712 = T.7424

.743 × .552

17 5.8823 / 6.8823 = .7696

.855 × .8377 = T.9319

.731 × T.8638 = T.7276

.534

18 5.555 / 6.555 = .7447

.848 × .8163 = T.9282

.718 × T.8564 = T.7128

.516

19

5.263 .7213
6.263 .7968
.840 T.9245
.706 T.8490
.499 T.6980

20 5. .6990
6. .7782
.833 T.9208
.694 T.8916
.482 T.6832

25 4 .6021
5 .6990
.800 T.9031
.640 .640 T.8062
.410 T.6124

30 3.333 .5228
4.333 .6268
.769 T.8866
.575 .592 T.7720
.350 T.5440

592
2
1184

592

$$\mathcal{H} = \frac{\mathcal{E}^2}{R} \qquad R = r + \frac{l}{n}$$

Work in lamp =

$$\mathcal{E}_l = \frac{\mathcal{E}\,\frac{l}{n}}{r + \frac{l}{n}}$$

$$W_l = \frac{\mathcal{E}^2 \frac{l^2}{n^2} \frac{l}{n}}{\left(r + \frac{l}{n}\right) \times \frac{l}{n}} = \frac{\mathcal{E}^2 \frac{l}{n}}{r + \frac{l}{n}} \div$$

$$\frac{\mathcal{E}^2 \left(\frac{l}{n}\right)^2 \frac{1}{l}}{\left(r + \frac{l}{n}\right)^2} \qquad W \frac{\mathcal{E}^2 \left(\frac{l}{n}\right)^2}{\left(r + \frac{l}{n}\right)^2} \frac{1}{l}$$

200 965
903,5

3.9845
3.9557
1.0288

1.06

1.775
8225

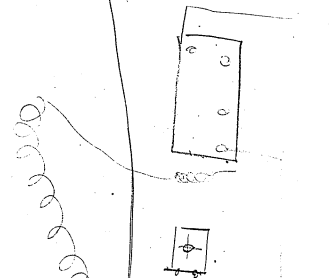
1.2492
.9157
.3341

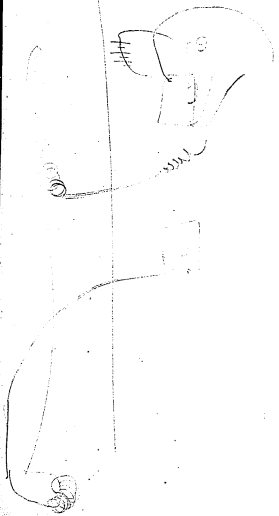
2.16 Ohms

2455
7545

.3901
.8660
.5241

334



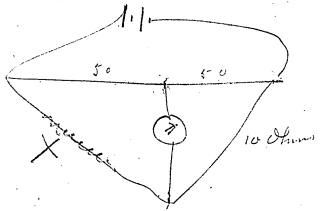


Portland Portland Portland Portland Portland Portland Portland

Sanft Hal. Folk. G.

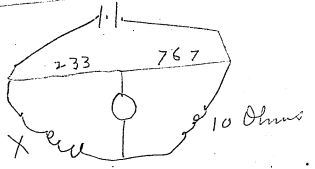
52½ 30 2
48 10
22 190 R
55 174 R
50 24

Solarium
Protinum
Cherok Lacinium
Marcinium
Prosium Dinarium
Protinum 16,
Machine Dinarium
Machine 12
Machine Phorinum
Machine 1 84.
81 19



50 : 50 :: 10 : X

$X = \frac{500}{50} = 10$



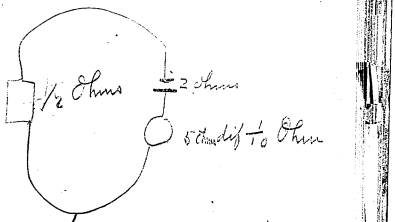
767 : 233 :: 10 : X

$X = \frac{2330}{767}$

500

$\frac{1}{7.5} \div \frac{1}{10} = \frac{1}{75}$

$\frac{1}{15} \times \frac{1}{75} = \frac{1}{1075}$

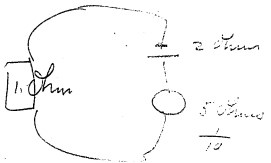


$\frac{1}{7.5}$ $\frac{1}{75}$ div in Amount

$\frac{1}{15}$ current in circ

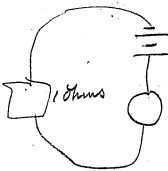
$\frac{1}{15} \times \frac{1}{75}$ $\frac{1}{1075}$

$\begin{array}{r} 75 \\ 325 \\ 75 \\ \hline 1075 \end{array}$



$\frac{1}{8}$ $\frac{1}{80}$

$\frac{1}{8} \times \frac{1}{80} = \frac{1}{640}$

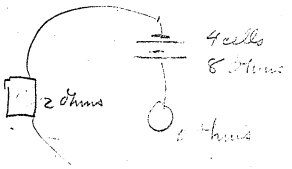


~~10~~ Ohms total

$\frac{1}{100}$

$\frac{2}{10} * \frac{1}{5}$

$\frac{1}{500}$



$\frac{1}{15}$ $\frac{1}{150}$

$\frac{4X2}{15} = \frac{8}{150}$

8) 150 (281

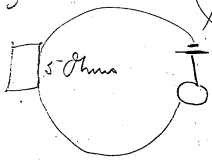
1 0

$\frac{1}{281}$

214

5 Ohms

10 Ohms



120 Ohms Total

$\frac{1}{120}$

$\frac{5}{12} \times \frac{1}{120} = \frac{5}{1440}$

$\frac{1}{190} = \frac{1}{248}$

~~$\frac{1}{14} \times \frac{1}{10} \quad \frac{1}{121.8}$~~

215

$\frac{1}{10}$

4 Ohms

$\frac{1}{110}$

$\frac{4}{110} \times \frac{1}{110} = \frac{4}{12.10} = \frac{1}{302}$

~~10~~ 6 Ohms

$\frac{1}{13}$

$\frac{1}{13}$

$\frac{1}{13} \times \frac{1}{130}$

1 — 1/80

1/8 = Current

1/64 of Else in Coil

1/64 X 1/80 = 1/5120

80
5120

2 Ohms

2/81 X 1/90 = 2/7290 = 1/3645

7/2/9 — 1/90

90

3 Ohms

1/64 X 3/100 X 1/10000 = 3/10000000 = 1/3333333

10 — 1/100

4 Ohms

4/121 X 1/110

7/4/110 — 1/5324

11
4
121
110
1210
121
4 | 13310
3326

5 Ohms 1/120 — 1/12

5

744
120
2880
144
5 | 17280
3456

3456

218

6 Ohms

$\frac{1}{130}$

$\frac{6}{169} \times \frac{1}{130}$

$\frac{7}{6}$
$\frac{13}{13}$
$\frac{13}{39}$
$\frac{13}{169}$

$\frac{1}{3661}$

130 | 1.0000 (0.00769
1000
910
900
780
1200
1170
30

169 | 6.0000 (0.0355
507
930
845
850
845
5

$\frac{1}{2}$ Ohm

$\frac{1}{7.5}$

7.5
7.5
375
52.5
56.25

$\frac{1}{75} \times \frac{1}{7.5} \times \frac{1}{75}$

112.5
75
5625
7875
8437.5

75 | 1.0000 (0.0133
75
250
225
250
225
25

7.5 | 1.0000 (0.133
75
250
225
250
225
25

1 Ohm = 1
2 Ohm = 333 1/3 = 2 1/333
3 Ohm = 249 7/11 = 3 1/42
4 Ohm = 801.5 = 4 1/2
5 Ohm = 1836 = 5 1/21
6 Ohm

748 1/2

249) 400 (1
249
151

2) 249
124 2
1

249) 400 (1
249
151

2) 249
124 2
1

141) 700 (4
564
136

21) 29 (1
21
8

332) 140 (0
0
140

2) 332 (166
2
13
12
12
0

2) 166 (83
16
6
6
0

83

676) 3244 (4.8 6370

2604

636

5 ohms Total

716.5) 2863.00 (4

2868

139.5) 5570.0 (39.9

5571.0

399.5) 12500 (.03

1197.0

45100

716) 22440 (31

2148

692

399.5) 12500 (.03

1197.0

51.50

716) 69200 (.96

6444

4760

4296

464.0

716) 2863.00 (4

2864

24

716) 69200 (.96

6444

4760

4296

464.0

one ohm combination

1 500 : 500 :: 1 : ? = 1 ohm

2 333 : 666 :: 1 : ? = 2.003

3 249 : 751 :: 1 : ? = 3.016

4 199.5 : 801.5 :: 1 : ? = 4.019

5 164 : 836 :: 1 : ? = 5.097

6 139.5 : 860.5 :: 1 : ? = 6.169

5 ohm combination

4 716 : 284 :: 10 : ? = 3.96

10 500 : 500 :: 10 : ? = 10

15 399.5 : 600 :: 10 : ? = 15.03

20 332 : 668 :: 10 : ? = 20.12

25 284 : 716 :: 10 : ? = 25.21

1 911.5 : 89.5 :: 10 : ? = .981

2 836.04 : 1.96

3 772 : 228 : : 2.95

284) 7160 (25
568
1480
1420
284) 6000 (.214
568
320

9115) 89.500 (.981+
82035
7465 0
7292 0
173 00
91 15

836) 1680 (2
836

836) 1640 (1.96
8040
7524
5160
5016
144

772) 2280 (2.95
1544
7360
6948
4120
3860
260

716) 2840 (3
2148
692
644
48

716) 3030 (4
2864
166

716) 2840 (3.96
2148
6920
6444
476

7100
142
2856
7144

(714.4)
300
786
244

876
924

95
914

974 : 26 :: 10 : ?

260
260

260 | 10
974) 260000 (.26
194 8
6520
5844
676
52

2 | 26 | 13
100 | 50

2832 4

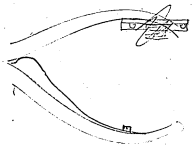
2920
2124
796

~~3775~~

708 : 292 :: 10 : ?

708) 2920 (3

703) 2920 (4



Sept 11 1879.

Saint Louis
Electric Light

Chas Batchelor

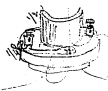
Edison Laboratory Note Book No. 13.

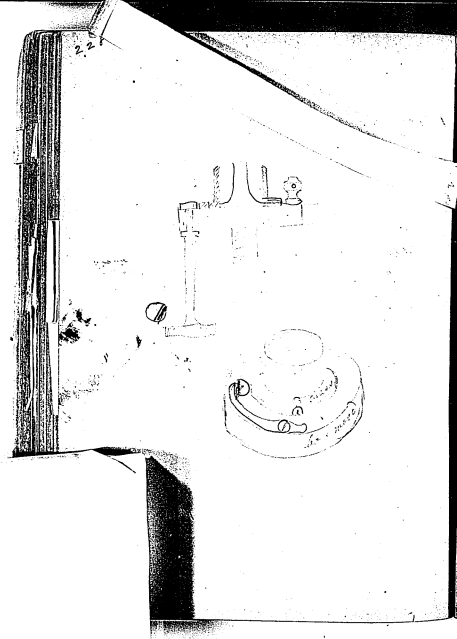
Pages 227 & 228.

See Edison Patents:
214,636
214,637
218,800
227,027
227,028
227,029

Sept 11 1879. 22

Sand stone
Electric light





Telephone parts

1 Wooden base
2 " box
3 " box Cover
4 Rubber Receiver box
5 " " cover
6 " " back.
7 Receiver bridge
8 " Palladium Spring
9 " " " nut
10 " " washer
11 " " washer connection
12 Receiver adjusting screws 4
13 " " " pin
14 " " rubber
15 " Brass chalk barrel
16 " " " washer
17 " " " nut
18 " Mica diaphragm 18 thou 20 d
19 " Connection strip 00
20 " Straps

21 Arm
22 Shaft guard
23 Worm wheel and shaft
24 Movable bearing
25 Worm bracket
26 Worm,
27 Handle (Brass
28 Handle (Composition)
29 Worm guard (dirt)
30 Arm bracket
31 Arm joint washer
32 Shaft sleeve
33 Bracket pin
34 Paper washer on joint
35 Coil spool
36 Coil winding
37 Bell
38 6 Bindposts
39 2 Keys with backpoints
40 2 front front points
41 2 Brackets with backpoints
42 2 Key buttons

43 hinge springs (2)
44 2 connection for cover
45 Transmitter base
46 " cover
47 Boxwood ring
48 " " connec. Strip
49 Bottom platina screw
50 Glass disc
51 top platina disc
52 Diaphragm with bush
53 Diaphragm Screw
54 Rubber bush
55 " Screws
56 1 Joint Screw
57 Rubber tube for Receiver connection
58 " connection wire
59 10 Copper washers
60 Coil Core
61 Bushings for Receiver 17/32 & 5/8 Ebonite.

18

Transmitter	$1.35
Bell	1.05
Receiver	3.25
Balance Box, Cord, etc.	4.00
	9.65
	1.25
	10.90
~~1.25~~	
	$12.15

Mr Jurnist Chalk roller
and palladium 12.15 / 28 / 12.43

~~Shipping~~ Packing the 28 cts per
~~telephone~~.

Then $13.00 - 20 = 12.80
Then $13.00

2898

Transmitter

Oct 1st 89.

1 To turne Drill & tap both castings the faces of both must be perfectly true. the Diameter of face Diaphragm to be 2 1/4 inch exact. Casting must be smoothed on both & lay flat on box, Depth must be same as our first piece.

2. To make box wood ring

3. " " & platinize & Brass screws

4. " which will be furnished in the rough for you make " " " the top plate &

" " make & put in glass disk

5 " make concaction plate & Concactions

6 " Assemble after Japaning Diaphragme with screws & heads Vagues " if not japanned on both sides.

7 rubber bushs

8 To solder & blue the screws & Vagues them To put it on the box for 75¢.

Receiver

1 To make the shaft rollers complete
The screws washers & nuts are furnished
as blank punchings
rollers to be turned to size exact
platin'd & drilled & taped & hence
japanned

Extra rollers for 25 d.

2. The Diaphragme to be cut & drilled
& put in case

3. To make the spring complete
to size exact, the Palladium
to be put on so that it does not need
any filing not to be wetted
with any fluid, highly polished
without emery, finished straight
& exact to size.

4. To make connections with # 3 d6
35 wires

5 To make the rubber piece to
size & shape same as model

6 To put spring on Diaphragme & set
it correct.

for 60 d dirty

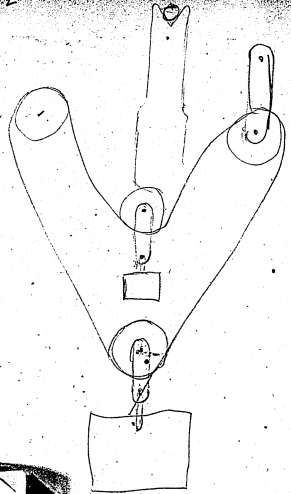
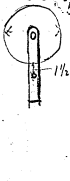
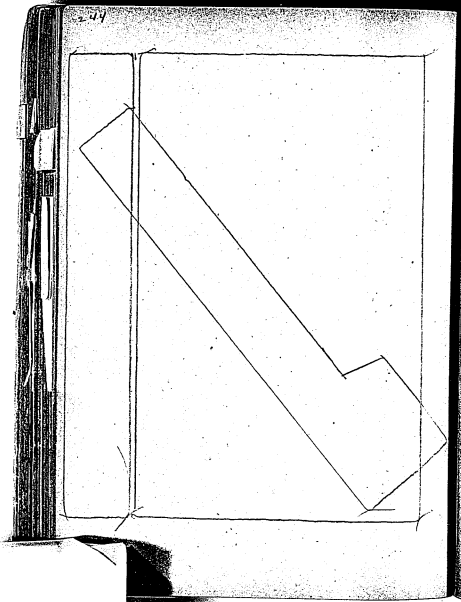


Fig. 5 inch wheel grooved the armature runs the sewing machine motor





Sizes of Packing boxes for Telephones

Oct 21st 99.

small

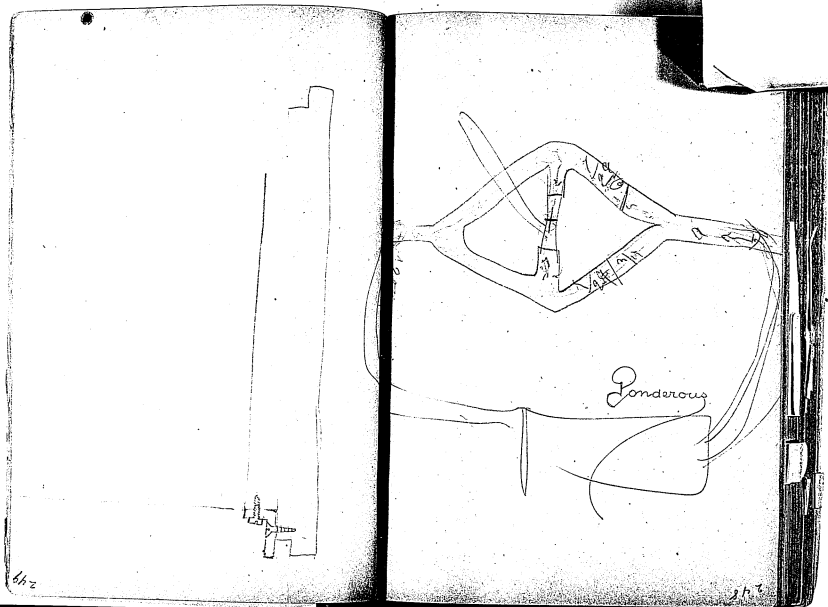
6½ × 12 × 8 deep.

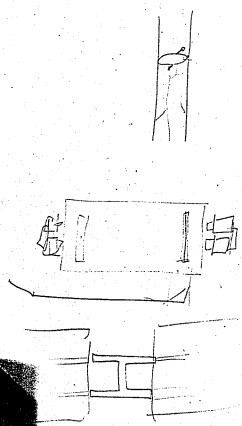
large

17 × 55½ × 12½ deep.

all inside measure.

18 Drill
3
16 "


Londerous



1/4 mile 8in Water pipe
Cast Iron and Laying
$2500 rough.
pipe 1575 00
Laying 925 00
2500 00

1200 HP
Condensing Eng. & Pumps
~~Invested~~ Leaving Interest
Non condensing plant
in $50 000 in Engines

$1600 less invested in
Boilers

1/3 less water for Boiler

252

253

1/3 less room for Boarders

1/3 less depreciation on boilers

Saving in Journal #1460 per year

Saving in cost

per Contra

Extra Cost of Coal &c over Non Cond. #1460.00

Depreciation Acct

Cost of piping, wells etc
for Condensing water (Wasted)

Saving in Boiler water
by using Condensing water
over and over $\frac{2}{3}$ (Surface Condenser)

For 1200 H.P. Boilers we should
want 8000 feet of Condensing
surface

We Copper pipe for $\frac{1}{32}$ thick $\frac{5}{8}$ hole
takes 32000 feet long @ 1280#
for ends = 1 33280#
= 12380 lbs at 38¢
= $4704.41

Cost of Condensing Engine
per hour per H.P. at 2½ lbs
~~Coal .918~~
~~Water .03~~

Coal	.31
Labour	.13
Oil Waste	.016
Rent	.11
Labour doubling	.13
	.122
Water	.05
Interest	.17
Depreciation	.01
	.948 cts

Jam

1

4

Cylinder 14 X 24

$\frac{14}{42}$ Repair diameter

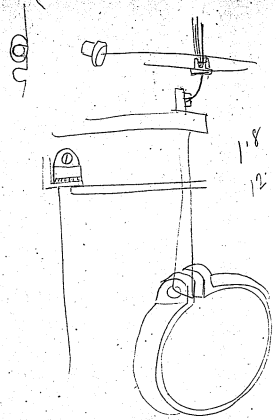
$\frac{56}{196}$

$\frac{1}{6}$ stroke average pressure 31 lbs.

Pressure 6076 lbs. piston speed

500 ft per min = 42 H.P.

4 Cylinders = 288 H.P.

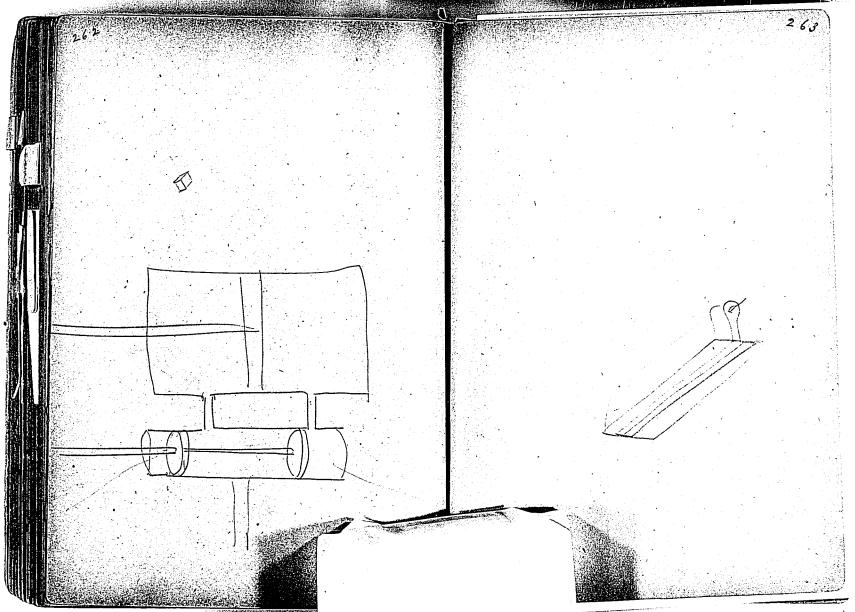


Cylinder 14×24 contains 3696 □ inch. 3696×2 = 7392. Then 7392 ÷ 1728 = 4.27 cu ft of steam at 1.8 atmospheres. 4.27 × 1.8 = 7.28 cu ft at pressure atmosphere for each revolution. Then 7.28 × 125 = 910 cu ft per minute

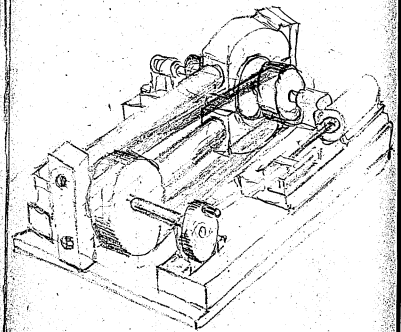
910 ÷ 28 = 32.5 lbs water per min. 32.5 ÷ 10 = 3.25 lbs coal per min — 3.25 × 60 = 195 lbs coal per hour

195 × 4 = 780 lbs per hour

250 H P at 3.25 = 812 lbs ℔. Coal per hour



March 3 1880



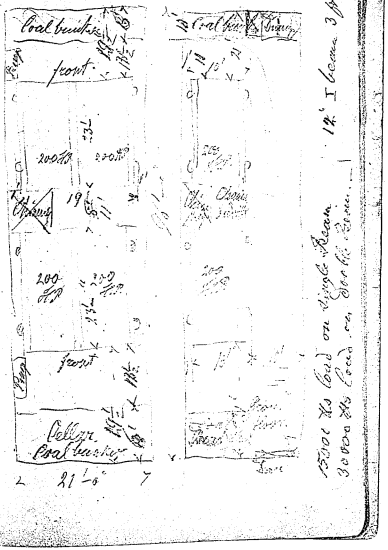
One Station 1250 H.P. 180 Revs
5 - 250 H.P. Engines - to design of Fig. 15 ?
1880

Belts - 1 @ 7000
Shafting & pulleys 5500
Iron Structure - 8 000
Woodlagging - 3 000
5 Engines 12 500
5 Engine Foundations 2 500
40 Forges &c. Machines 36 000
Boilers 25 000
Heating & Cooling 7 000
Steampipes
Chimney 1 000
Building

Page
21 Gr. widths
96 - Smiths
33 - Machine
15 - Boilers
165 - Engines

1250 I.H.P.
3 lbs. Coal per I.H.P. per hour for 10 hours
37500 = 17 tons average per day.
100 tons at 35 cubft = 3500 cub ft should be stored in bunkers.
Make 6 bunkers 8 ft wide 5 ft. deep
6' x 8' = 54 sq ft Chimney — 5 to 50 sq ft ...
7 1/8" Square outside. —
7" (Internal 6 sq") Steampipe for about 250 ...
6" " (32 sq") " " 300 ft ...
5" " " Total 1250 ...

30 lbs Water per hour per lbs ... advanced standard.
1250 H.P.
30 lbs water per 10 hours
375.000 lbs Water consumed per day.
46 800 gallons
Pump capacity 4700 gall per hour ...
place 2 Pumps to 400 ft 3" 100 gallons each ...
and 2 " " 200 " " 800 " " ...


B & M. Boiler Plant.
Coal bunkers
Front
Chimney
Boilers
Coal bunkers
Boilers
Coal bunkers
Front
Boilers
Coal bunkers
Boilers
Coal bunkers
Front
Boilers
Coal bunkers
Boilers
Coal bunkers
Front

Boilers for Kelly Water Works Station
Made there

80 H.P 66" diam 16 ft long 69-4" tubes
3½" × 42" Dome – (then $912.00).–

7" diam. (40 Sq ins) Steampipe for each 250 H.P Engine –
6½" " (32 sq ins) " " " 200 H.P
6 × 32 = 192 = 15½" ins diam for all 5 Engines

350 Plant: of 3 H.W. but 9 instead of 8 rows of tubes, add – 6" to height –
Plan for Albert from other Plant. –
Chimney 8 ft Sq in clear. –
14 ft. Sq. outside
18'-11" outside of Brickbench –
88" each batt 17" width of Walls.
6"x4" wide buckstay at middle
9"x6" wide Coal posts
36" diam of drums – about 18' long –

Smoke flues each 36"×30"–

21" pitt. below floor.
9'-11" height of Brickwall at front end
11'-6" to centre line of drum & Water line
13'-6" to top of columns & Bottom of 36 12" Supporting Beams.
18'-5" centre to centre of bearing beams
29" front of wall to centre of 12" Support
15" front wall to front 24" Bridge –
7'-6" to Mud drum on 12" Support
3'-2 to end wall – 12" ins wall –
42" c. to c. of Steam drums. –

p. 40

Mathiesbrop extension - Bill of Timber

25	Floorbeams	3" x 18"	22'-6"	long pine
23	Roofbeams	2" x 12"	24'—	"
2	Sills	4" x 16"	23'—	yellow pine
4	—	— " —	27'—	" "
1	"	— 4" x 12"	27'—	" "
4	Stringers	— 6" x 6"	26'—	" "
5	Trusses	— 8" x 12"	23'—	" "
10	"	8" x 8"	12'—	" "
9	Posts	— 10" x 12"	15'-6"	" "
5	"	— " —	12'-6"	" "
9	Braces	— 4" x 8"	6'—	" "
4	"	— 4" x 6"	4'—	" "
10	Uprights	— 4" x 6"	12'—	white pine
2	—	2 x 6	12'—	
2	—	4 x 6	15'—	
2	—	"	14'-6"	
4	—	"	13'—	
2	—	"	13'—	
2	—	2½" x 6"	13'—	
4	—	"	12'—	
6	—	"	15'—	
6	—	"	15'-6"	
8	—	2" x 6"	4'—	

Roofing 600 sq. ft. of 1" [illegible] 5.21
600 " " 1½ pine
Roofboard 700 " " 1" board seam.
Flooring 701 800 x
Siding - for 700 sq. ft.
Trimming 12 wide
5 Windows
2 Doors
Partitions
10 Loads Bonham 6.00
10 Barrels cement
Brickwork
70 ft. x 15½ x
60 ft. x 1' x
8500 bricks
9000 bricks

Machine Shop extension —

26'9" — 3½" Shafting with 5 Hangers 30"

26'9" — 2½" " " 5 " 20"

20 Pulleys — 6" face 32" diam.

1 Pulley — 25" " 36" "

1 " — 17" " 36" "

1 " — 26" " 60" " for 3½" Engine

1 Shaft 3½" — for Exchange

2 or 3 Hangers 3½" — 30" drops

Belts.

20 — 5" — 25' long 15 long

1 — 12" — 24' —

1 — 24" — 24' —

1 — 24 — 27' —

Total Estimate

Wood Resist. Shafting Pulley $2800

Caloric Experiment.

8" area = 50.265

area × 6½ stroke = 314 cub. in. per stroke = 1 revol. — water piston 3½ stroke

16" 2¾ = 376
8" 1¾ = 47½
8" 2¾ = 198
620 inch long pipe 4" Diameter forms.

Condenser Engine three places

Pistn 16" diam = 201.06 × 10 = 2010.6 sq. inch
4 7/8 area = 471
2480 ÷ 5 sq. inch heating surface

6 of 8" diam = 25.13 × 10 = 251.3
8" area = 50.265
301.565 sq. inch heating surface

contents from above
5/8 heating surface 1963 × 625 = 1227.5 sq. inch heating surface

Heat transmits the surface for heating and evaporizing at 212 degree — compared with Cast Iron Stove heating.

Air and all other Gases & Gases have same expansion, that is 1/491 = .002037 times of their bulk for every degree of heat. — (Specific gravity compared with water = .00120196) that is they expand from 32° to 212° = from 1000 to 1376

8" area = 50.265 × 3½ = 176 Cubic inch the cyl contains

By equal pressure Steam has 3.136 times the specific heat of Air — and at equal volumes 1.965 times

20 Volumes of Water absorb 1 volume of air

Anthracite one ℔. requires 195.45 cub. ft. air
Bituminous " " 150.35 " "
Coke " " 108 " "
Wood " " 90 " "

1250 ℔. P. × 3.8 = 4750 ℔. per hour.
or about 63 ℔. per min. requires
63 × 200 of air = 12600 cubic ft per min.

№ 10 Sturtevant Blower = 1000 revolutions per min.
= 1/15 350 = 600 revol. per min. 60" Diam. of Blast
14" Diam of pulley 12 face 10 Centre of Bearings
24" Diam of inlet — 18" × 24" Square of outlet.

9.76 Horsepower.

10 H.P. Vertical Engine 4½ Cylinder 8" stroke. 36" Diam of Flywheel 12" face
300 ℔. weight 200 revol. per min. 16" 32 Diam
room 69½" high — room 9 ft. to ceiling = 315 ft.

1 ℔. of Coal requires 9 ℔. of air
= 1250 × 9 = 11250 cubic ft. = 187 cubic ft. per min.
25 to 30 ℔s of Water per hour

Locomotive Boiler 12 to 14 Cyl 8" stroke 16" D

Cubic — continued

7⅞ area = 48.7 × 11½ "steele" = 560
+ 2½ " fall 5 × 7/8 = = 3¾
8 area = 50.265 − 11.78 × 5/8 = = 7¼
− 7 area = 38.484
6" area = 28.27 × 175 − 178 = = 20½
Content in Chamber = 590 cub inch

Pipes...
16 × 21 3/4 long = 348."
8 × 23 " long = 184"
4 × 10½ " long = 42"
= 574 ins. Length of pipe

5/8" cubic diam of pipes = .3067 × 574" = 176 cub inch
5/8" inside diam " " = displaced by pipes

590 −
176
414 cubic ins. content for air in Chamber

314 cb. ins. content displaced in 6% per steele

5/8" area = 1.963" × 574" length of pipe = 1126 3/4 sq inch heating surface of pipes =

Erickson's heating Rat offers 990 square inch inside surface to the acre or about 1/4 of 3 square pipe surface.

6" area = 50.265 = 50 cyl. Gasser Cubic —
7½ " = 38.484 = 38 cyl. replacement 10 cubic
= 88.749 = 88 cyl.
12

8 Wood fillings = 60 cub ins.
16 " = 85 "
8 " = 15 "
1 " = 4½ " 20%
4 " = 5 "
1 × = 1 1/16
1 × = 1/16

displaced by Wire 213 cubic ins.
Cubic = 20%

414 174 cubic ins. 42%
240 88
174 31% cyl. [illegible]
[illegible] 120 cyl.

6" area = 50.265 Cyl. [illegible]
× 4.5 " [illegible] = [illegible]

226 414 [illegible] 120 = 3 [illegible]
174 88
52 26% [illegible]
314
88
226

March 16 1880.

Temperature of Room 17° C.
Exhaust air at slow speed - 67° C.
" " " fast " - 69° C.

Exhaust Steam varying from 98 to 102° C.
apparently not affected during work of Air engine

Pressure in Air engine 10" Mercy of Vacuum 15"
even while Exhaust heat operated best by hand
slow motion was given to revol - -

With smallest addition of Steam 42 revol per
62° Temperature of exhaust steam.
Add Steam 60 revol - 65° - " "
" " 75 " - 68° - " "

March 17th.

Air & Steam 30 revol with Condenser of
very small condensation in cyl.
" " 50 " Without " only
very marked condensation in cyl.
" " 52 " with Condenser of Steam
very small condensation in cyl.
" " 32 " Without " only

Menlo Park Notebook #17 [N-79-04-21]

The dated entries in this book begin on page 75 and cover the period April-November 1879. The earliest entries are a series of undated notes by Edison relating to the work of Sir William Crookes on vacuums, which are followed by drawings of vacuum pumps. These entries probably relate to a series of vacuum experiments for electric lamps, conducted in February and March 1879. The rest of the book is by Francis Upton and relates to electric light experiments. Included are notes, calculations, and tests on generators, motors, and batteries; drawings of generators; calculations about electric light systems; and notes on a regulator "to make a ten ohm lamp equal to an 100 ohm." The label on the front cover is marked "Theory" and "Upton." The book contains 284 numbered pages.

Blank pages not filmed: 20-21 46-47, 234-249, 280, 283.

Missing page numbers: 281-282.

176/7

GENERAL ELECTRIC.
Schenectady, N.Y. U.S.A.
May , 189 c

Crokes says monohydrated Sulphuric acid evolves vapor He replaces it with Phosphoric anhydride for drying the gases he says nothing about washing it the pumps with it. yet he used the former for that purpose.

He use a tube stuffed with gold leaf between the receiver & the Vacuum bulb.

He sometimes uses air absorption to carry Vacuum still further.

working with air he finds that at
a pressure of 40 millimetres of an Atmosphere
a spark whose striking distance
at the normal pressure is 1/2 an
inch, will illuminate a tube having
aluminium terminals 3 millimetres
apart. but when he pushes the
exhaustion still further the 1/2
inch spark ceases to pass but
a 1 inch spark coil will still
illuminate the tube.
The nearer he gets to a vacuum
the more power it requires to drive
the spark through the tube but at
the highest exhaustions he still
gets indications of conductivity
when he uses a 6 inch spark
coil. = With such coils there is
a tendency of perforating the glass
& give a slight cracking of
the —

he says that these perforations are so minute that it take several days to show themselves –

He exhausts down to 2 millionths of an atmosphere –

He keeps the vacuum pump during exhaustion in a hot air bath heated to 300° C. for some hours to drive off the occluded gases from the interior surface of the glass – perhaps our ~~Equal~~ will accomplish this

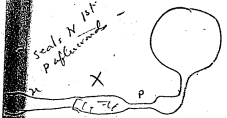
Use burnt India rubber on his stop cocks – he melts it & lets it fall on the ground surface –

stoppers not near so good as sealing

Uses an geissler tube single points standard Carl & Sachs to judge of the progress of the vacuum -

This becomes uniformly luminous as you go higher its becomes obliterated Then Luminous at the poles only then black & non conducting -

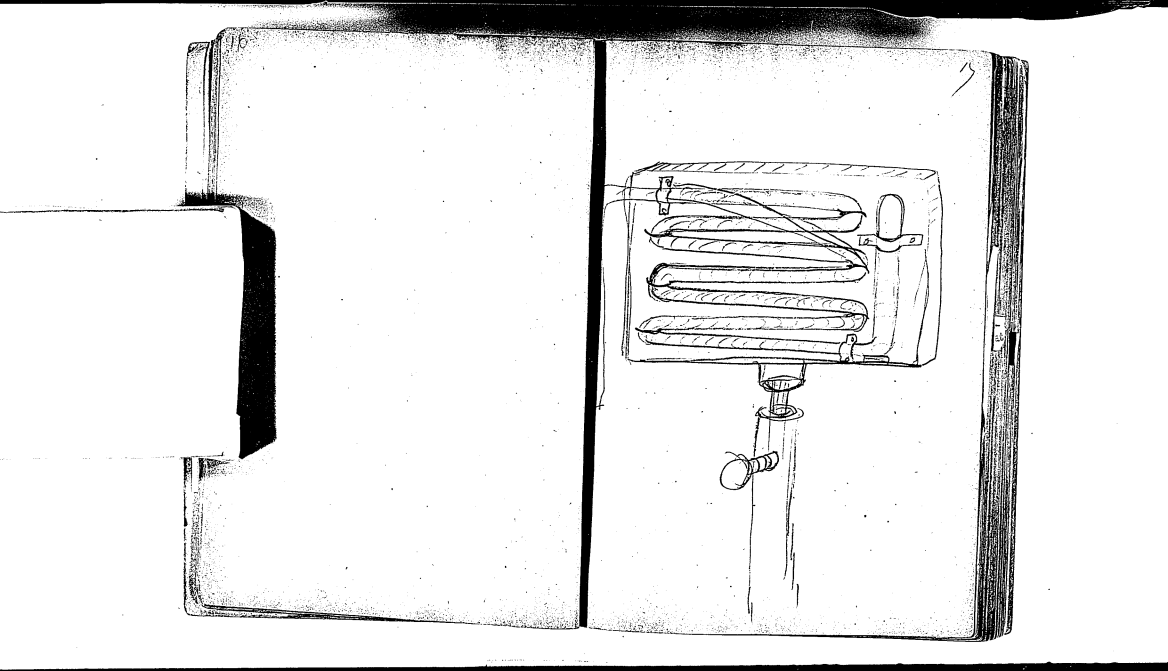
Crookes seals his platinum wires in long small tubes & these he seals in the main tube, this he says is requisite to prevent leakage —

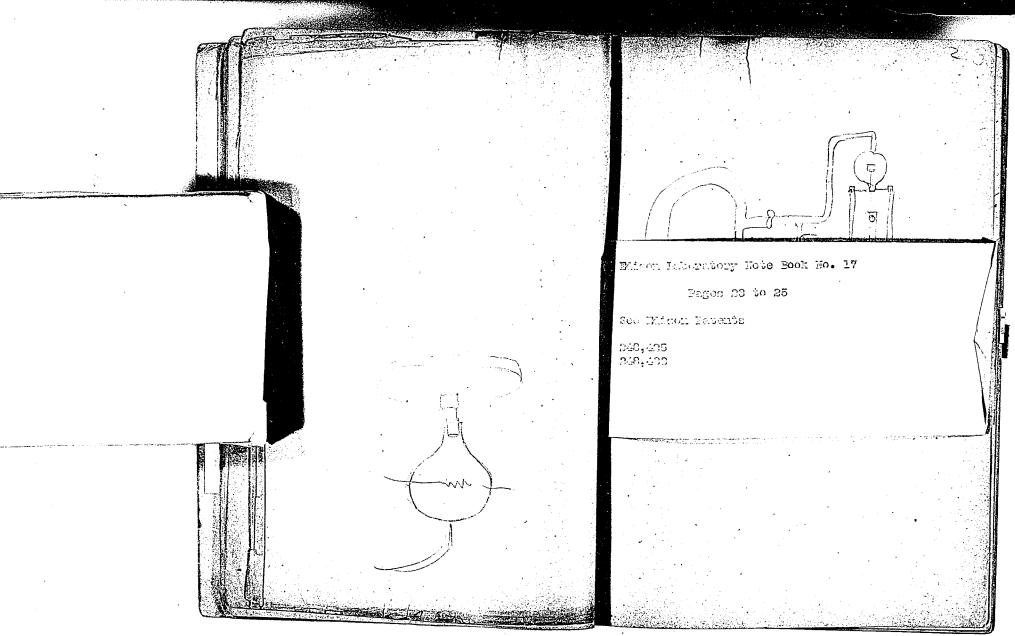


Uses cocoanut charcoal in X. Exhausts & then leaves for 24 hours or more so that the Charcoal will absorb all the residual gas then seal this off.

uses a tube 6 inches long
tightly packed freshly ignited
Cocoanut-shell Charcoal.
After vacuum the charcoal tube
is heated nearly to the softening
point of glass when the occluded
gases are given off from the
charcoal & depress the Mercury
gauge 30 to 40 millimetres.
The pump is worked rapidly
till gauge is brought up
again, the heating of the
Charcoal is repeated when more
gas is given off & the gauge is
again depressed although not
so much as before this is
repeated until the heating

the Charcoal ceases to
depress the gauge
Then the whole is sealed off
leaving Charcoal in connection
then set aside for some weeks
When the Charcoal will absorb
the whole of the residual
gas & leave the vacuum so
perfect that it will not conduct
an induction current, then
Charcoal tube & then sealed off



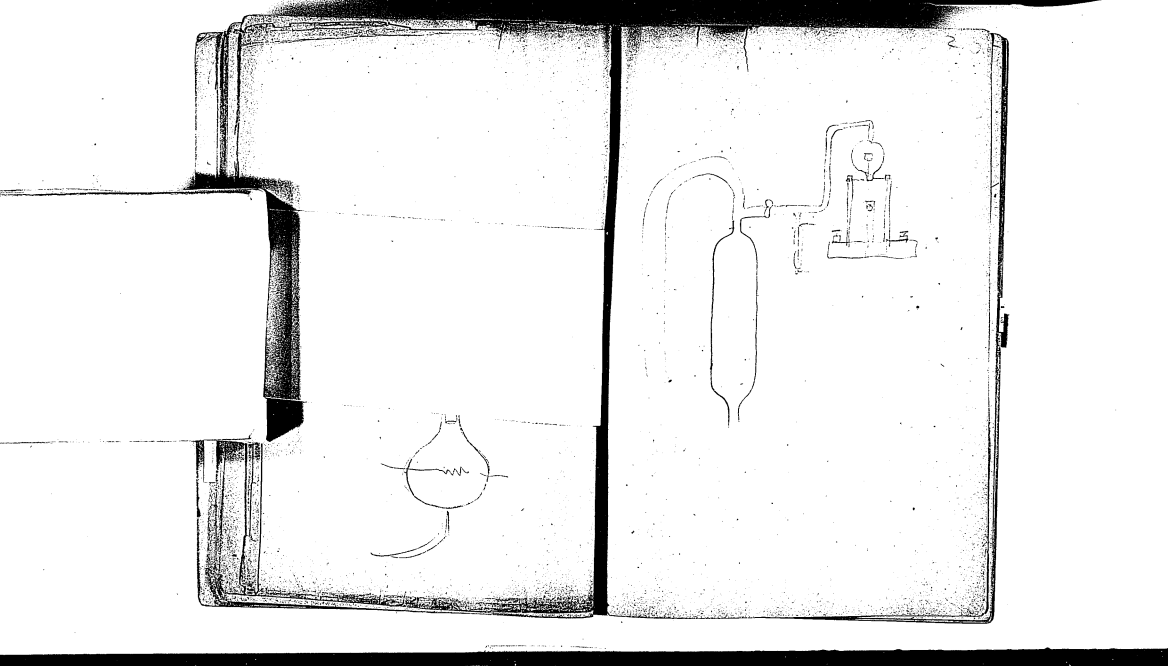


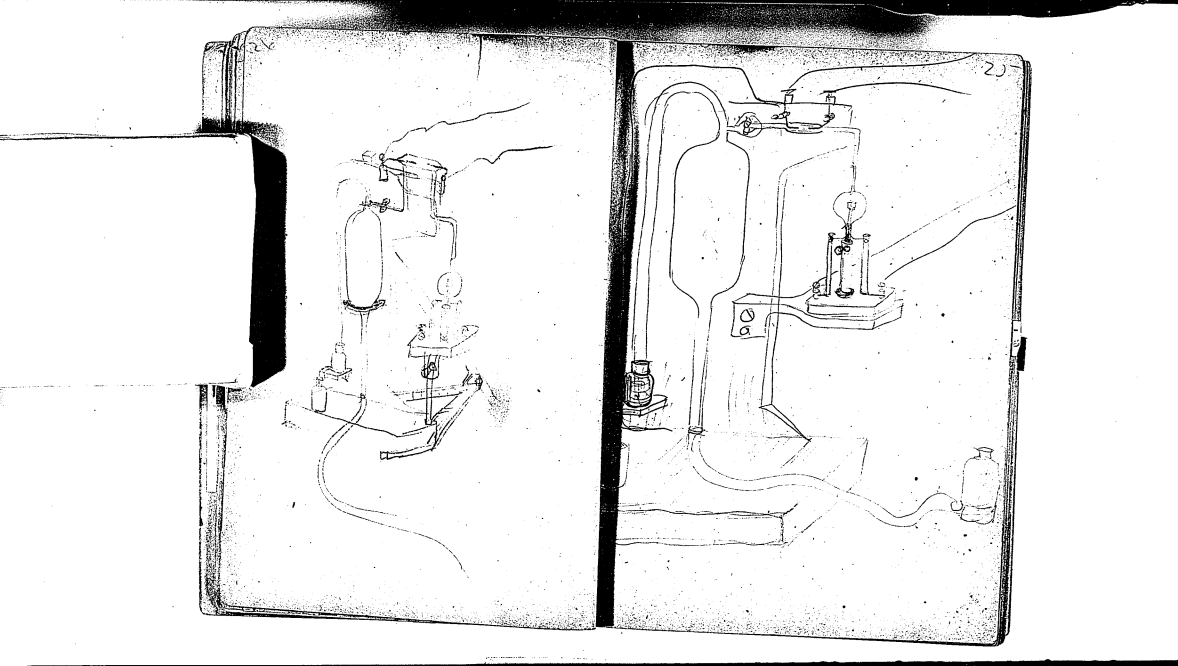
Wilson Laboratory Note Book No. 17

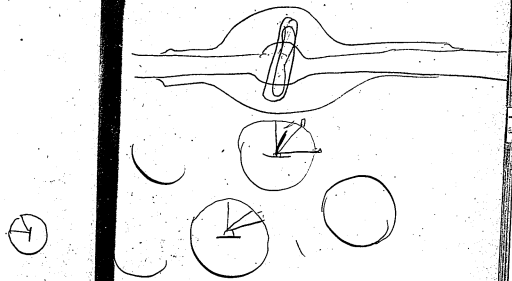
Pages 22 to 25

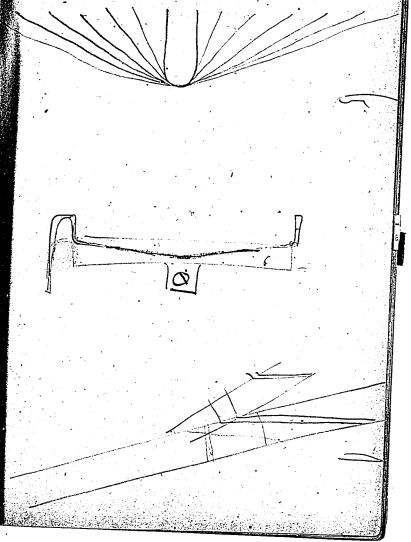
See Wilson Patents

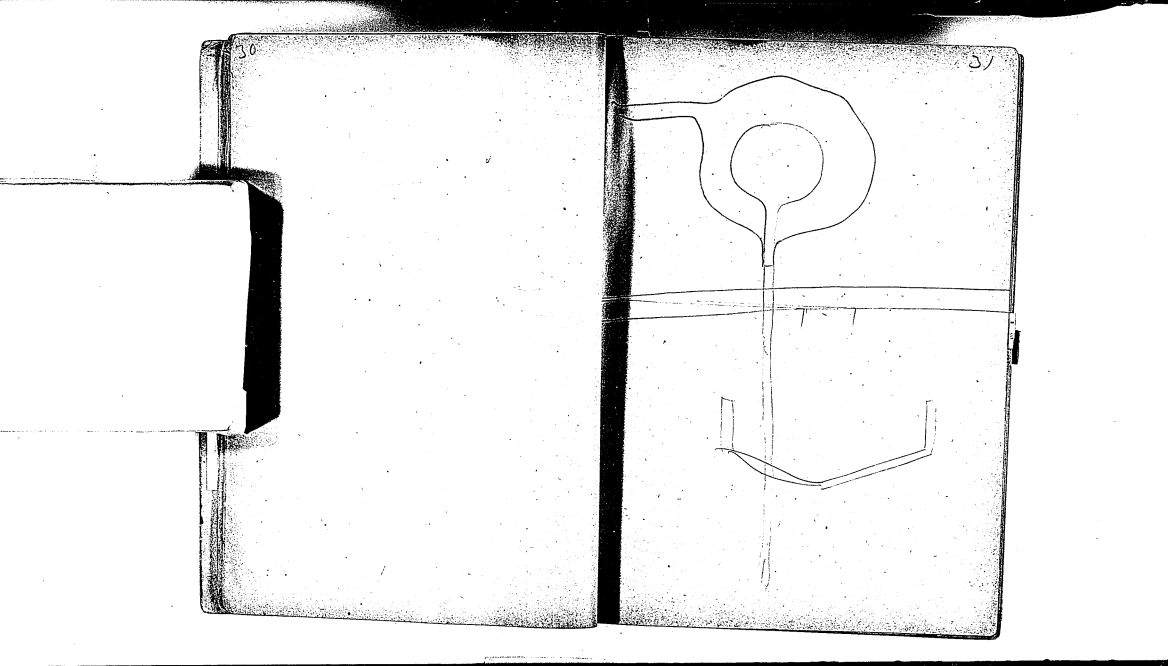
320,295
320,270

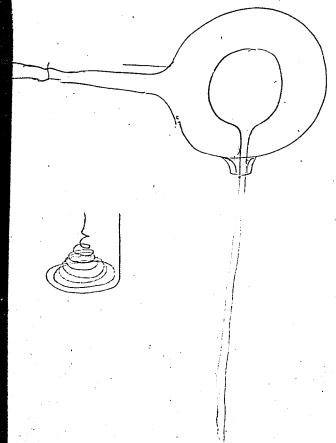


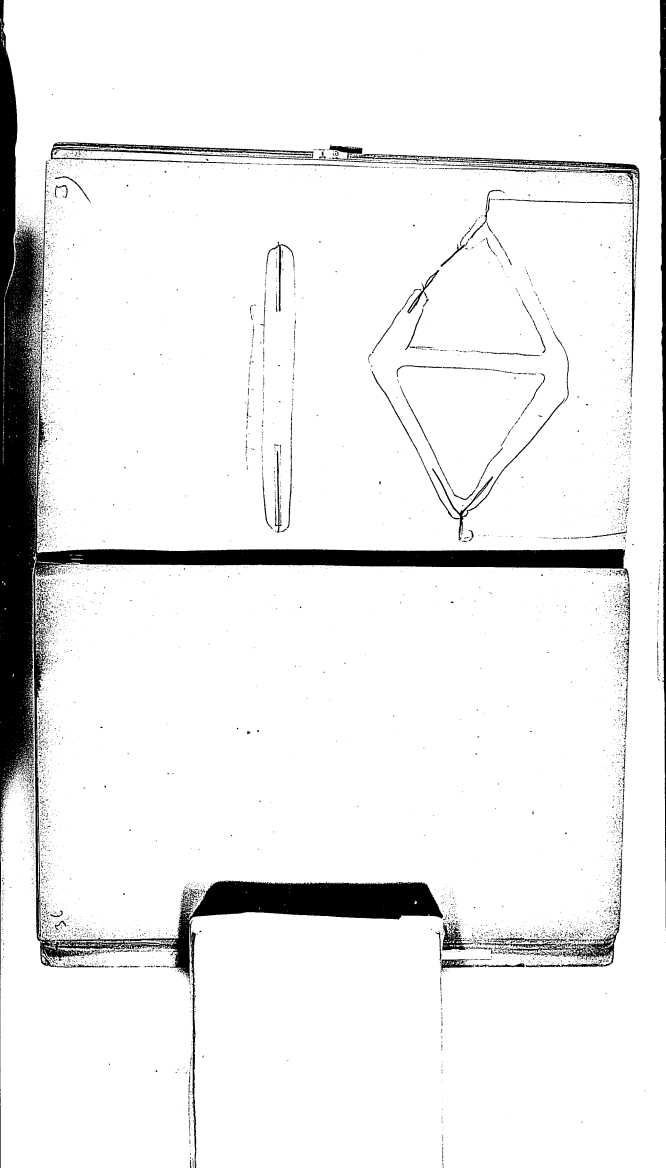


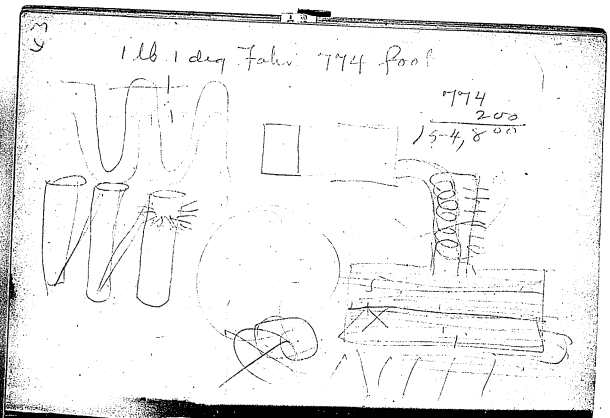


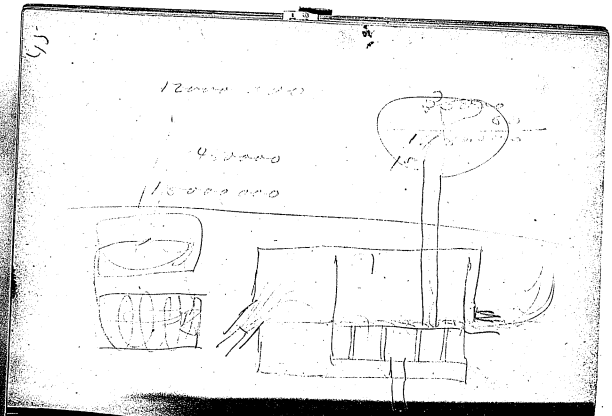


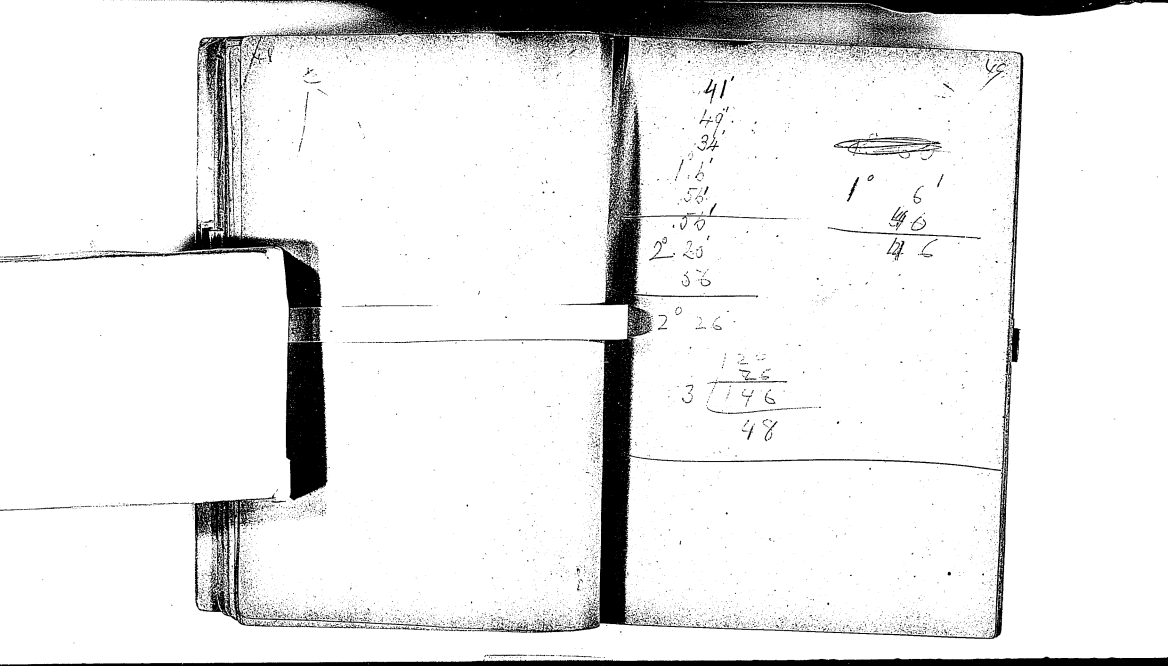







1 lb 1 deg Fahr 1774 Proof
1774
200
1574





Let it up where wanted

Prepare Shunt for Silver

About .07
wire about .05
Line 1.17

Paint

3000

3000

6000 ft lbs per minute

10

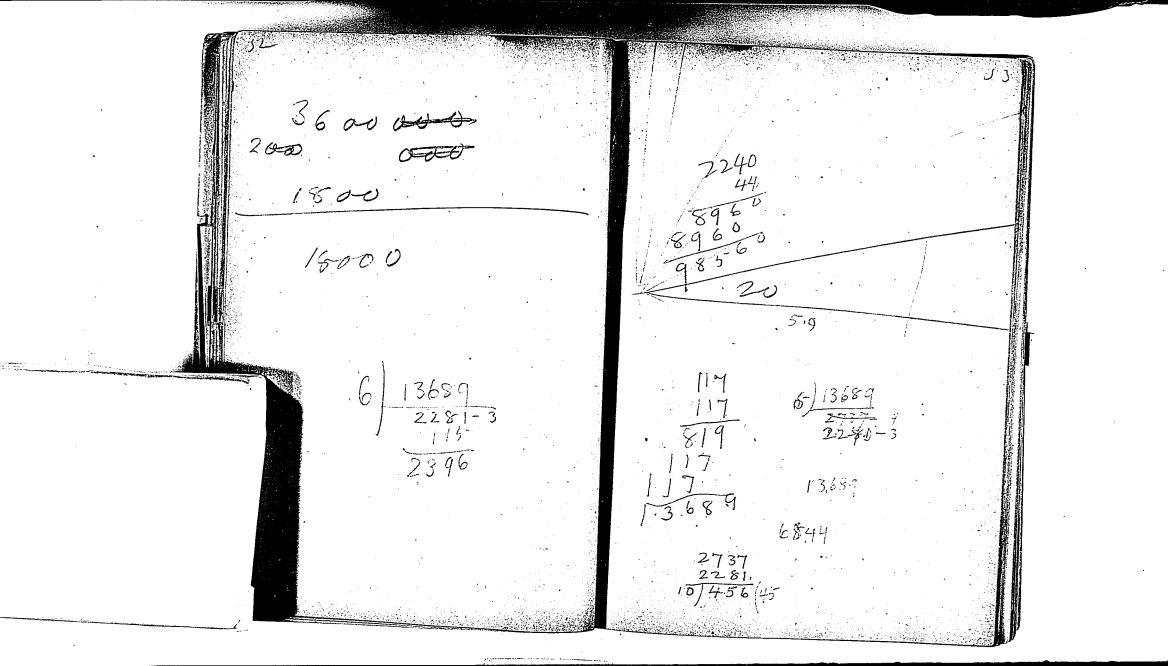
600

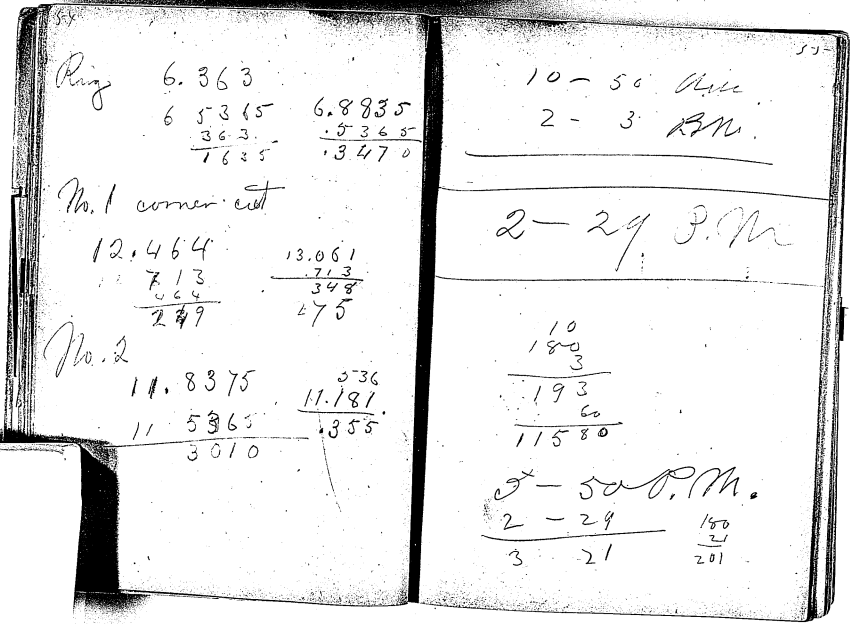
3.6 ~~0 0 0 0 0 0~~

33 ~~000~~

108

60) 10.8


SL
3600
2000
1500
15000
6 | 13689
2281-3
115
2396
SJ
2240
44
8960
8960
9856
20
5.9
117
117
819
117
117
13689
13689
6844
2737
2281
10 | 4561 45



5x

Ring 6.363

6 5 3 6 5

3 6 3

7 6 2 5

6.8935

5 3 6 5

3470

No. 1 corner east

12.464

7 1 3

5 6 4

2 9 9

13.061

7 1 3

3 4 8

4 7 5

No. 2

11.8375

11 5 3 6 5

3010

5 3 6

11.181

3 5 5

5x

10 — 50 A.M.

2 — 3 P.M.

2 — 29 P.M.

10

180

3

193

60

11580

3 — 50 P.M.

2 — 29

3 21

180

21

201

.275

.275 Grammes

log .275 1.4393
Colog 11580 4.0637
5.3756

.0006237

.00326 3.5132
5.3756
137. 2.1376

1 Danielle on about 137 ohms
On reality there was not
more than 13.7 Ohms

Battery 2 ohms
3
2
6 ohms
Perhaps commute S. M. F.

− 2° 40′
+ 5′
2° 45′

+ 3° 25′
2° 40′
6° 5′

58

120
45
165

6
60
360
5
365

165 2(2.2175
1.1087
7901
.3186.

2,08

12.6

.3186
1.1871
1.5057

32.0 Webers

Grammes vers 1.4 autres
24 total

54

0 2° 32'
2 8
24'

2 = 2. m. 7

2
.13

.13) 2 0.3010
.13 1139
1.1871

15.4 Webers

24 2(1.3802
.7901

60

32 1.5705-7

2.4 0.3802

1.8859

42. 1.5057

1.6232

5.0148

102,000.

5.0148

33000 4.5185

.4963

3.1 H.P.

740 revolutions

24

16

20 24

6 16

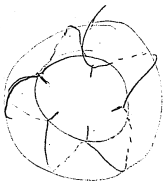
188 24/16 X 5/20/6

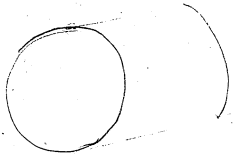
940 4

Measure the machine
~~[illegible]~~ a circuit
when warm.

To determine the E. D

-.44'
+ 2
46'





66

77

4.331

.061

2 (2.356
1.178

3.6

36

65

305 mm Diameter
152.4 in Radius

$\frac{1}{50}$

$\vartheta = \frac{e}{2\pi} H \cdot tg\alpha$

$H = 2.06 =$	0.3139
$b = 152.$	2.1818
$tg\ \alpha = 3°36'.061$	2.7853
comp $\frac{1}{50} =$	9.5036 −10
comp 2π	9.6990−10
	0.4836
	2.7853
	1.6978

3.0

$\frac{3}{10} = .3$ Webers

Since Point Res unit of E.M.F. is 1/10 of Webers

.6978

66

Large plate

102.5 ft 4

Small plate in dish 3.5 Ohms

Small plates 3.6 Ohms

Weight

67

No. 1 corner cut

13,004
12,674 5
329 5

No 2

10,864
11,186
322

Fresh carbon cells
Through 3.6 Ohms

4-35 P.M
8° 20'

4-42 9°

5 P-M
8°

$\theta = \frac{G}{2\pi} H \operatorname{tg} \alpha$

$H = 2.06$
$G = 152$
$\alpha = 9°$

comp 2 Page 65 1.6978
cond π 9.1997 - 10
.8975

7.89

7.89

.789 Webers

if Volt = 10^{10} $\frac{\text{Wm}^2 \text{ Ohs}}{\text{Sec I}}$

Voltameter

.000 326 Grammes / Weber
1 second

.325 Grammes

25 minutes
60
75 00 seconds

log .325 = .00 1.000.
Comp .000 326 .000000X
Comp 1500

1000
1500

2/3 Weber .666 Webers

2/3.6 2/3.7 Weber

E = 2.2
R = 3.7 Ohms

Ohms

3.7 2 2 1.13424
37 1.56582
T.7742

.594 Webers

72

Ring 4.3007
4.655
3097

no.1 12.625
13.4175
.7925

no.2 11.186
10.3775
.7985

73

3.3 Ohms Basin

3.6 Ohms Plates

Put on 8-53 P.M.
290
8-55 28° 30'
9 1 28 05'
29°
29° 15'

9-28
35 Minutes

Galva constant

Range 65 1.6948

log .2845 9.7392 − 10

1.4370

27.3

2.73 Webers

$\mathcal{E}$ = 4.2 Volts

Resistance = .2 + 1.7 = 2.7

2.3.4
1.7

4.2 / 2.7 .6232 / .4314 / .1918

1.55 Webers

Could not determine from the deposition of Cu on the current was so strong as to deposit it in granules.

April 21 1879

Determination of the Constants of Tangent galvanometer

Heavy plate 109 mm by 92 mm

76 April 21 1879

Large plate
Corner cube

98.625
99.808
1.183

1,153
1.1 cos.
2.2838

86.178 2
37.279
1.1008

2 small plate
No. 1 corner cube

13,4155
9.6365
3.7890

No. 2

10.3517
14,061
3.7093

1 cell corrections

274

77

Through

240

3700
3
22205
14 m - 0
36 200

277
27
247

Not on Zero

78

1 Daniells cell
3600 Ohms + Galvanometer

65 to the left
74 to the right

2)139
695

Shunted on 1 Ohm +

19 to the right
19 to the left

3)69.5
23.16

76 to the left
76 to the right

77

1 Carbon cell

220 to right
210 to the left
210 to the left
220 to the right

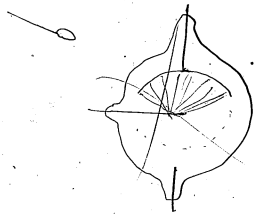
0 at zero

Through the galvanometer and 1 Ohm.

187 to the right
181 " " left

Deflection Tan. gal.

190 151



60° 30' tan +65°

Short circuit

65 to the left

58° 30'

59 to the right

57° 30' +1°

55 to the left

53 to the right

185 to the right

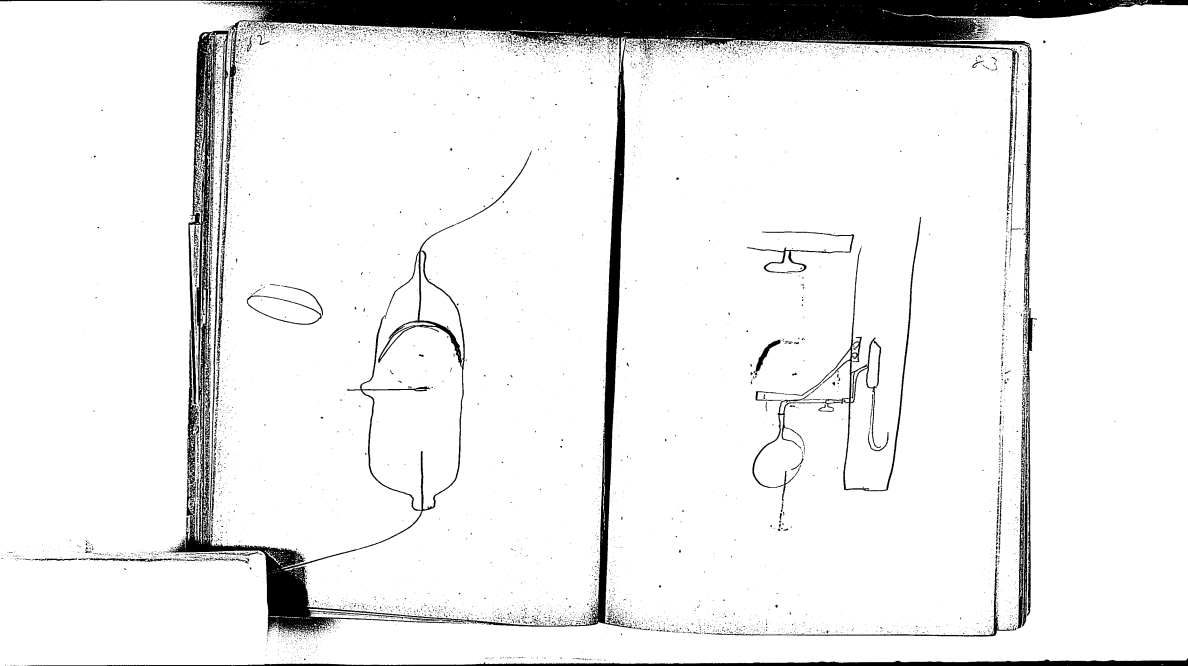
195

195 to the left

205 to the right

About 5 minutes

Under the battery



Cathode

200

Another cell

200 to the P

Another determination

205 to the left

213 to the right

205 to the left

203 to the right

Through 10 ohm & Galvo

175 to the left

175 to the right

175 to the right

18° 30'

Ghost circuit

55 to the right

~~55 to the left~~

58°

55 to the left

57 30'

50 the right

56 15'

195 the right

200

204

193 to the left

200 to the left

198

210 to the right after five minutes

203 right

205

Resistance

107
5
1.02 Ohms

Daniells

60 to the left

30 to the right

65 to the right

70 " " "

Zero changed

~~Carbon~~ Carbon

207 to the right

198 to the left

again zero and these numbers

207 to the right

Carbon on 102 Ohms

175 to the right

20° 15' ≠ D

166 to the left

18° - 45'

Short circuit

50 to the left

58°

48 to the right

700

45 to the

57°

---

after short circuit

175 to the right

Fresh Carbons

215 to the right

205 to the left

420

210

Poor Daniells plain cork

65

Good Daniells

106 to the right

105 to the left

103

~~100~~

104

Carbon 216 right

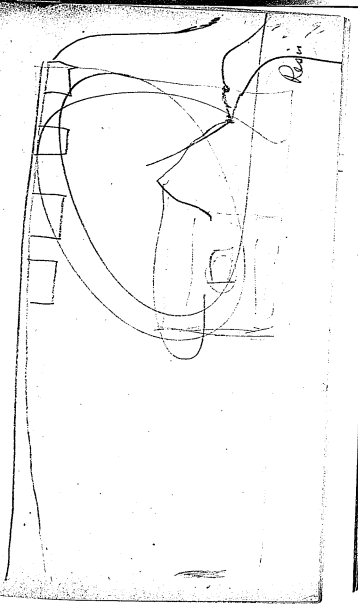
208 left

90

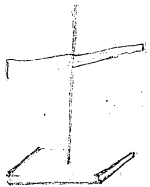
Results

Daniells 105 Ω

Carbon 280 Ω



92



53

Wt of round Cu

~~4.4025~~

4.3155

6-13 P.M

on .05 Ohm shunt

5.7 Ohms E.M.F. assigned

The correct

11 a.M.

4.317 Wt of rod

.0025 in grooves

in place of short

.037

contrary E.M.F.

Dynamometer

2° 26'
1°
1 26
60
56

2°. 30
1°
3°30
180
210

1° 30'

1° 43'

+ P 29'
56
33' on Dynamometer

40° 30' on Galva

36° 45' on Galva

29'
27

57'
27
30'

52
24
28'

50'
51' Does diminish
28'
23'

55'
28
27'

545
26
28.5

51'
12
40

2 cells of Carbon through
Galv. Dynam and about .90 ohm

54
25
29

High resistance galvanometer
around

305 to the Rt

140 to the left

2 cells carbon

220 to the left
230 to the right

620 Radius

225 2.3522
620 2.7924
9.5598 -10

.363 tan 20° = .363
20° R = 1

.74 Ohm in shunt
round galvanometer

2 Carbon cells have each 2.1 V.
of 2 Daniells or about 2.1 Volts
Total 4.2 Volts

225 = D

225/4.2 23522
.6232
17290

53.5 D for 1 ~~Volts~~ Volt

over .74 Ohm

April 21

40	2.1461	
53.5	1.7284	
	.4177	

2.6 Volts over .74

$C = \frac{E}{R}$	2.6	0.4177
	.74	1.8692
		.5485

3.54 Webers

4.2	0.6232
3.54	0.5490
	.0742

1.18 Ohms in circuit
or the battery polarizes since
there are External .86 Ohms
and internal .2
1.06 Ohms in circuit

April 22. 59

3 Ohms in circuit with
two carbon batteries.
two cells of Voltameter

10 dash.

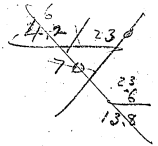
24° 30' tan. galvanometer

High Resis Sol
70 to the right
.68 Ohm
Shunt

took off 11—5
2 Carbons direct
214
215
230.

.68 Ohms in Shunt

2 carbons have E.M.F. of
4.2 Volts



$\frac{4.2 \times 700}{230}$ $\frac{4.2}{7}$ 29.4

29.4 1.4683
23 1.3617
.1066

1.27 Webers

Ohms Volts Webers

3.2) 4.2 (1.31
32
100
96
40

$\frac{210 \times 42}{230}$

21		1.3222
4.2		0.6332
comp. 23		8.6385
		.5937

3.92

3.92	0.5937
3.2	0.5051
	.0886

1.23 Webers

Amt deposited in 65 minutes 2.284 Grammes

See page 76.

	2.284	,35588
comp	65	8.1871
comp	60	8.2218
comp	.000326	13.4868 - 10
		0.2545

1.8 Webers

60	8.2218
.000326	13.4868
	21.7086 -20

Tan Page 65

Tan. Gal. constant 0,6978

Log tan 24°30' 9,65587

.3565

2.27 Webers

1,23 Best
1.8 Good
2.27 " for nothing
3)5.30
1.76 Webers average

I do not understand why these results are so far apart

I think the method with galvanometer of high resistance is the best

Trial April 22 of a g. in Pt. Crucible with Daniells

Wt of Pt Crucible

15.8975
16.2245
.3270

Daniells 171 to the left

2 6 P M

D = 48 left

Zero at 1 to the right

D = 42

R = 605

Taken off 2-46 P.M.

2.85 Ohms in Pt crucible
7
2.78 Ohms

2.04
7
1.97 Ohms in Shunt

2.78
4.75
2.00
6.75 in all

Silver April 28

40 mumble

.3270 Ag

.3290	T 5.145
Comp 2400	5.6198 — 10
Comp .001116	12.9508
	T.0851

.121 Weber

Galvanometer

42	1.05
172	1.97

.42	1.6332
1.05	0.0212
Comp. 172	7.7645 - 10
Comp. 1.97	9.7055 - 10
	19.1244

T.1244

.133 Weber

Total circuit

1.05 Volts	.0212
6.75 Ohms	8.293
	T.1919

.155 Webers

This seems to be more nearly correct yet far from exact factory. Shall now try two coils of Daniells using silver and Cu. voltameter

Silver April 28

40 minutes

.3270 Ag

.3290	Ts 145
Comp 2400	5.6198 — 10
Comp .001116	12.9508
	T.0851

.121 Weber

Galvanometer

42	1.05
172	1.97

42	1.6332
1.05	0.0212
Comp 172	7.7645 - 10
Comp 1.97	9.7055 - 10
	19.1244
	T.1244

.133 Weber

Total circuit

1.05 Volts	.0212
6.75 Ohms	8.293
	T.1919

.155 Webers

This seems to be more nearly correct yet far from satisfactory. Shall now try two cells of Daniells using silver and Cu. voltameter

April 23. 1878

Cu ~~plate~~ disc Ag put in same circuit 1 Daniells

Wt of corner cut Cu

~~31.0215~~
31.1965
31.6865
.4900

Cu
31.449
30.940
.509

.498

Cu
16.180
17.8715
1.6905

Ag
Ag 126 12.9508
8.2218
21.1726
7.5591

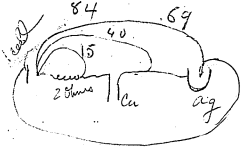
Comp 1.6905 9.7721
.498 1.6972
.001116 3.0473
5.5166-10

.000328 in place of .000326

time 10-37
Estimated 3.9

Current around 2 ohms
15° to the right
E.M.F in 2 ohms

15/84 .69



240
36
276
60

25
84.5 X 2
Cu per minute 1.7086
Comp 276 7.5591-10
1.6972
9.9649-10

1.1761
8.6731
9.6990
.91482
1.1482
= .14 Webers

Constant of Galvanometer

Time 11 - 15 A. M.
started 2 - 20 P. M.
$\delta = 22° 15'$
$D = 20'$ 11.27 dyn
Page 76 $H = 18°$ 1.25 G. M.

Wt of plates
comm cut 99.808 Grammes

10 2.625
2.817

120
65
185

37.279
40.1045
2.8255
2.817
5.6425

I find the current through the tangent galvanometer of one coil. Through a Voltameter with two cells in multiple arc. Through the Sygnamometer and

Ohms

A galvanometer having 39.00 Ohms outside and Ohms internal is placed in a Shunt having Ohms, the galvanometer being placed on a shunt

Around Ohms is placed a circuit having 36.000 Ohms and high resistance differential galvanometer. This measures the current in E. M. F. on the shunt and from this the current may be calculated

2 Daniell cells
204 to the right

1 Daniells
99 to the right

1 Daniells 100
100 to the right

2 Daniells
204 to the right

Changed the Galva
2 Daniells
170 to the right
1 Daniells
84 to the right

Another
1 Daniells 85 to the right
84
169

Zero

Reversed
2 Daniells
169 to the left

1 Daniells
84 to the left
1 Daniells
85 to the left

1 95 = D to the right
over shunt of
tan Gal 18° 30'
29'

The plates

205
96
109 = D & d right

Jan 17°-

83 deflection

.71 Ohm .68 Ohm

.37
.34

43
through .37 Ohm

	.68	T. 8.3325
a	43.	1.6335
	83.	8.0809
		T. 5469

.352 Ohm calculated

comp	83	8.0809
	.68	T.8325
	109	2.0374
		9.9598 -10

.91 Ohms in Voltameter
calculated

There was no current

$$\frac{83 \quad 1.04}{84.5} = \text{E. M. F.}$$

$$C = \frac{\varepsilon}{R} = \frac{\varepsilon}{.71}$$

log	83	1.9191
	1.04	0.0170
comp	84.5	8.0734
comp	.68	10.1675
		20.1769

1.5 Webers

5.642 Grammes Cu deposited in 185 minutes

5.642		0.7515
comp	185.	7.7328
comp	80.	8.2218
comp	.000326	13.4868
		30.1928

1.55 Webers

Galva

Page 65		1.6978
19° 30′		9.5491
		1.2469

1.76 Webers

17.6

Platinum Crucible

10.
5.
.500
.200
.010
.007
15.717

Copper No 1

50.
20.
10.
10.
.2
.1
.500
.200
.100
.008
93.808

Copper No 2

50.
20.
10.
10.
5.
1.
.100
.020
.002
96.122

Copper No 3

20
10
5
2
2
.500
.250
.050
.05
39.7655

97 1533
1 93.808
3.3453

43 1355
3 39.7655
3.4700
3.4121
2 6.8921 0
3.4455

Copper No 4

100.
2.
.200
.050
.010
.008
102.268

2 96.1228
92701
3.421

4 102.2685
98.833
3.4355
3.3453
2 1.67808
3.3904

97 right
96 left
Daniells
conc cu
1641/2504

96 right
95 left
Daniells

April 24, 1878.

1 Daniells
90 Right

Chg 24

Put on 8—21½ A-M

18° on Tan Galvan.

11—10 Acme

13° on Tan Galva

13° on Tan Galva

- Cu. Cell

Taken off 12-56 M

total Cu 3.44555

3.39704

64359 0.8035

56
39
180
275 rounds

camp 275 7.5607

17.0786

10.0728

.0728

1.18 Wolfers

1.23

Copper No 2.

50.
20.
10.
10.
9.
550
250
301 9/11

92.701 9/11

Copper No 3

20.
10.
10.
2.
1.
.25
.10
1005.5

43.135.5

Copper No 1

50.
20.
10.
10.
5.
2.
1.
583

97.153.9

Copper No 4

10
20
10
10
5
2
1
500
200
100
20
10
8

98.833.

1 Daniells
124 left

4 H_2SO_4
$CuSO_4$ Crescent
127 Right
125 left

1 Daniells
122 left
125 right

2 Daniells
235 right
117 right
117 right

.33
45
two 90

Again
Daniells
117

Again Daniells
114 right
114 left
114 right

2 230R. 114
228

Standard cells

125

Daniells

124 night
124 R

---

228 2 cells
124
124

360
120

2 cells 240 night

2

difference between the Daniells.

1 cell 114
another 125 R
126 R

Standard

Cu SO_4
114 H_2SO_4

gives 128 R
126 R
129

14° on tan Gal

44R = D over

44R =

89.5R = D ow

12 .32 Ohm
.33 Ohm

.65 Ohm

E. M. F

$\frac{44 \times 1.079}{126.} = E$

$\frac{E}{.32} = C$

1.6435
0.0330
7.8996 −10
10.4949 −10
.0710

1.17 Webers

14° .93967
.16978
0.09745

1.23 Webers

14° 1.17 Webers

19° 1.525 Webers

	1.17	.0682
comp to 14°		0.6033
to 19°		9.5126 −10
		.1841
	1.528 Webers	

.0682
.6033
.1715

4.69 Webers for 45°

4 3/4 Webers for 45°

April 25 1878

Cu Nitrate in porous cup
1 4 12 H_2SO_4 in outside 2 one
normal saturated

129 temp 15°

Daniells which yesterday
gave 125
today 128 temp 14°C
124 R

Cu. Nitrate
135 R
131 L

Testing E.M.F.

Daniells
111 R
111 L

Nitrate Cu
109 R

2 cells together
221 R

Nitrate Cu. another solution
105 R
105 L Temp 20°
107 R to 21°C

Daniells 110 R

132

Daniells
199 R
1.02 Daniells

Nitrate Cu
200 R
199 R
1 to 12
Water Sulphuric Neutral
a weaker solution 199 / 1.7122
19 R Gold
1.02 Daniells

weaker solution
Nitrate
196
4 to 1
water H_2SO_4

Comp log 100 / Comp log 194
$\frac{2}{\bar{2}.7122} - 16$
$\bar{1}.7122$
log 199 2.2989
2.0111
1.02

Sulphate Cu
195 R
1 to 4
H_2O H_2SO_4

Daniells
199 R
Sulphate Cu Standard Daniells
194 R = 1 to 12

133

Daniells
120 R
1 Dan | 1 to 12 | 230 K
cum log 120 $\frac{2.}{\bar{1}.92207}$
$\bar{1}.92207$
$2.36172\,30$
191 .2824 2.28

Chromate
100 H_2O
12 Bicromate of potash
25 H_2SO_4
228
205
1 to 4
1.91 Daniells
232
1 to 12

Copper wound round the carbon which brings the deflection down to 205 — in contact with liquid

Nitric acid Grove 1.38

215 214 216 — 1 to 4

Bunsen carbon 1 to 4

215 216 — 1.80

T. 1.9207
2.3345
.2552

Cuming Nitric

115 218 — 112 3

Carbon

219.5

220

220 — 1.83

T. 1.9207
2.3426
0.2531

220 1.83 Daniells

Daniells 120

136

These measurements seem to be good and consistent. Yet they do not agree with the numbers given by Clark & Sabine

~~I take the~~

Perhaps in changing the Zn from dilute to concentrated H_2SO_4 ~~then~~ I did not give time enough for change of solution on surface

137

~~0.034~~

$C = 1$

$\frac{1}{2}$ 1 MΣ $\frac{1}{4}$

$\frac{1}{4} \times 4 = \frac{1}{2}$

$\frac{1}{2}$ current

4 $\frac{1}{4} 2 = \frac{1}{2}$

21

16 Cells $\frac{1}{16}$ Ohm 1 Ohm

16	Cells =	16 Ohms	16 MΣ
8		32 Ohms	8 MΣ
4		64 Ohms	4 MΣ
2		128 Ohms	2 MΣ
1		256 Ohms	1 MΣ

Measurement of Zinc Amalgamation

Standard Daniells

Conc Solution of sulphate of Zn. amalgamated Zn

conc Solution of $Cu SO_4$

electrotype Cu.

D = 100 L

Daniells 95 L

100 L

96 L

291

305

Standard Daniells

100 L

102 R

2 cells 192

1 of the 102 L

the other 84

186

3 cells 308

4 cells off scale

brought 4 cells back to 50 division

Gramme machine

Dynamometer

70 lbs when no current from Gramme, this from permanent magnetism

3' to the right "Fiducial"

210 L

6° 10'

3

6° 13'

210 = D

over 1.53 Ohms

Dynamometer gives 6° 7'

with No. 2 shunted

6° 3'

5.02 Ohms Total in circuit

5.25 Ohms Hot

This was the total in circuit

Daniells

50 R 5th R Reduced

Dynam $10^\circ 4' 9''$

295 L $10^\circ 5' 4''$

In current 70 K = Deflection

Total 4.4 Ohms in circuit.

1.5 Ohms

Daniells = 1.09 Volts

After Kohlrausch. I take this number as given on good authority and also as bringing my calculations above rather than below what may be the truth.

$C = \frac{E}{R}$

$\frac{210}{50} = 4.2$ Daniells E. M. F.

$\frac{4}{16.8}$

16.8	1.2253
1.5	0.1761
11.2	1.0492
1.09	0.0374
	1.0866

12.2 Webers $R = 5.25$ Ohms

$E = CR$

11.2	1.0492
5.25	.7202
58.8	1.7694 Daniell
64.1 Volts	1.8068

$C^2 = \sin D$

$C = \sin i$

$20 = 2i$

$C = \sin i$

$D = 5^\circ 3'$

sin 6° 3' 2 | 9.0228 -10

4.5114 -5

log .324 =

12.2 Webers

.324	1.5114
12.2	1.0866
	2.4248
.0290	2
	4.8496

2' 26" 2 | 6.8496 -10

3.4249 -5

Constant of Dynamometer.

$\bar{2}.4249$, comp = 11.5751 - 10

Divide the equare root of the sine of the deflection by the constant and the result will be the No of Webers

$\frac{295}{50} = 5.9$

4

23.6 Daniells

23.6	1.3729
1.5	.1761
15.5	1.1968
1.09	.0394
17.2 Webers	1.2362
	4.4
69.3 Daniells	1.1968
75.8 Volts	0.6435
	1.8403
	.0394
	1.8797

sin 10° 49' 2 | 9.2733 -10

1.6366

1.5751 -10

1.2117

16.2 Webers

146

16.2 Webers
over one Ohm
42. foot lbs

16.2	1,2117
16.2	1,2117
42.	1,1232
	4.0466

18100 foot lbs over 1 Ohm
say 20 candles
505 foot lbs. per candle
per minute

198 over 1.5 Ohms

Total 4.47

.2' Fiducial

16° 14'

16° 4'

New deflection

Did not get the resistance

again

280 4.3 ohms

13° 45'

1.27 ohms

14° 46'

285 = 4 cyl

4 Daniells, 49

21° 33'

20° 58' just on slowly

22° 25' just on at once when coils were welded

24° after bringing up by putting

Battery in line so that these results

1.3 Ohms in circuit

22° 25'

23°

23° 40

1.1 Ohms

total in circuit 2.7 Ohms

D = 20° 23'

2 | 19.54099 - 10
7.7704 - 5
11.57751 - 10
16.34555 - 15

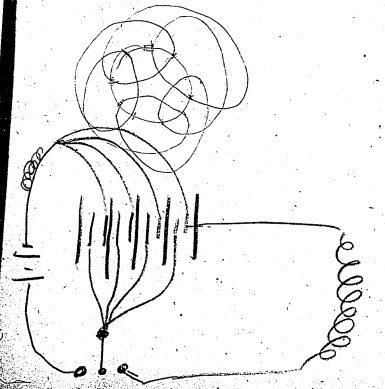
22.1 Webers 1.34555
.4314
2.7 1.7769 59.6

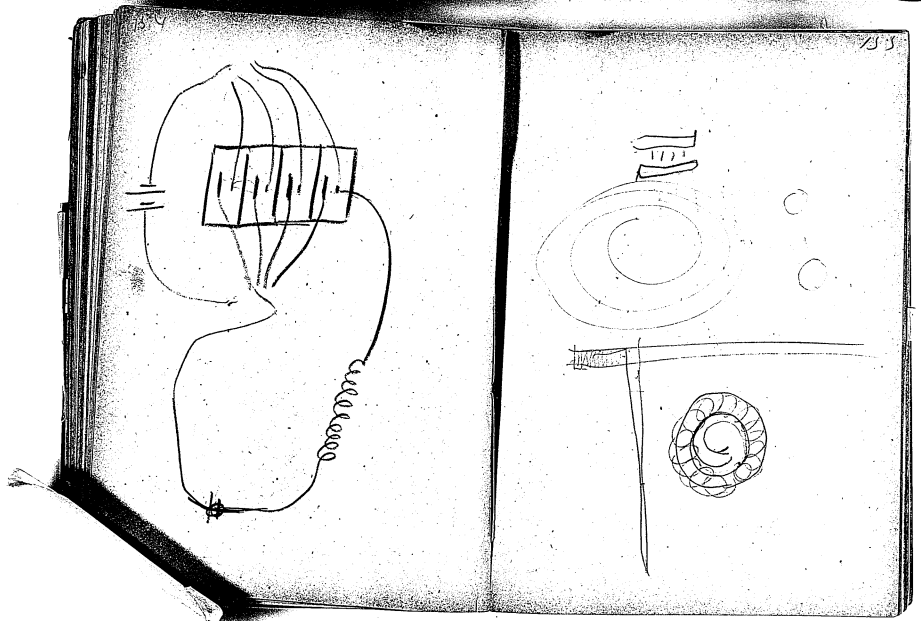
Speed 670

Total resistance	Webers	Volts
5.25 Ohms	12.2	64.1
4.4	16.2	75.8
2.7	22.1	59.8

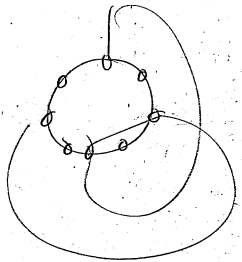
12.2	1.0864
12.2	1.0864
5.25	.7160
44.2	1.6454
34.200	4.5346
16.2	1.2095
16.2	1.2095
4.4	0.6435
44.2	1.6454
51.000	4.7079
22.1	1.3444
22.1	1.3444
2.7	0.4314
44.2	1.6454
58.200	4.7656

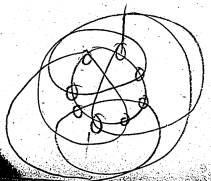
I want the curve of the Gramme machine. That is the relation of the amount of external resistance to the M. F.

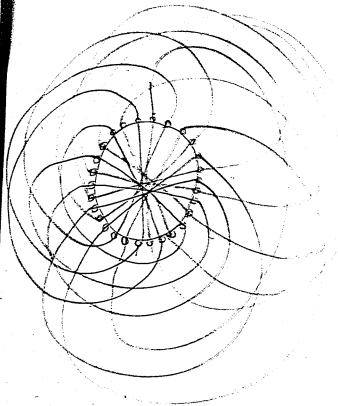




7°. 10'







154

2 2160 1

2155
79 8
79 6
111
553
6241
44
24964
24964

55) 2746 04 (

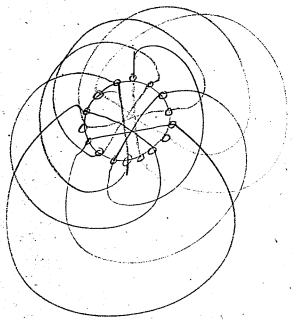
155 4 5
7
20) 1106 (55
100
106
100
6 2

7.3 : X : 20 : 158

55) 2746.04 (49.92 = 5
220
546
495
510
495
150
140

944 6 5

4.992) 33.000 (6
29952
3048
4992



155

160

981

$\frac{1}{981}$ Dyne ——— Force

$\frac{1}{981}$ Gramme through 1 Centimeter at Paris

This is a unit of Workor energy.

772

424 Kilo-metres
42400 - centi
2724000 - milli

~~42400 Centigramme millimetre~~

424000 mg gramme

1 ~~Gm~~ of H_2O heated 1° C

= 1 unit of Wk raised 424 metres
42400 Centi

~~Dyne~~ Erg = ~~Ene~~ Work against unit of force or Dyne

~~Dyne~~ = unit of force the force required to produce a velocity of 1 centi in one second acting on 1 Gramme

~~Dyne~~ Erg = work performed by the unit of force = Dyne in one second

= $\frac{1}{981}$ of the work performed in lifting 1 Gramme 1 Centi

= $\frac{1}{981}$ The work performed in lifting Gramme one Centimeter

The work required to raise 1 Gramme of water 1° C = The work required to lift the same weight one Gramme 42400 Centimeters

or 42400×981 Ergs

since one Erg = .981 of a gramme

42400	4.6274
981	2.9917
41600000	7.6191

4160×10^4 Centimeter-Gramme^2 / Sec^2

= Joules Equivalent

.003411 Grammes is the value of e for Zn, or the electro Chemical equiv. of 1 Weber of Current.

Favre & Silbermann give 714 Gram. Deg. C. as the amt. of heat developed by burning 1 Gramme of Zn in a Daniells cell.

Therefore the amount of work done by one Weber current passing through a Daniells cell =

$w = .003411 \times 714 \times 4160 \times 10^4$ Gram Cm / Sec

3.5330	
2.8537	
7.6191	
8.0058	

1.012×10^8 Gram Cm / Sec

The work performed by a unit of current is

107 $\frac{\text{Gram Cents}}{\text{Sec}}$

or $\frac{1}{10}$ of that found

Wiedermann's

.03411 Mm

I take the same example from Wiedermann

.03411 mg is the electro-chemical equiv. of Zn

or .00003411 Grammes

.00003411

C^2R $\quad C = \frac{\mathcal{E}}{R}$, $R = \frac{\mathcal{E}}{C}$

$\mathcal{E}$ $\quad \mathcal{E} = CR$

Work $= C\mathcal{E}$

The work done in a circuit is equal to the amt of heat given off by the consumption of the Zn.

$= e\,J\,W\,C$

e = electro-chemical-equiv.

J = Joules equiv.

W = Zn. that equiv.

C = Current in Webers

Work also $= C\mathcal{E}$

C = current

$\mathcal{E}$ = E.M.F.

If

A current ~~gives~~ being a certain amt. of zn.

$$a_3\ \partial w$$
$$e\ g\ c\ zn = \mathcal{E}\ C$$
$$e\ g\ zn = \mathcal{E}$$

not so

C on left is a numeral
C on right is a concrete no.

$$C = \frac{mm^{\frac{1}{2}}\ mg^{\frac{1}{2}}}{T}\ \text{amt. of elec}$$
$$\mathcal{E} = \frac{mm^{\frac{3}{2}}\ mg^{\frac{1}{2}}}{T^2}$$
$$C\mathcal{E} = \frac{mm^2\ mg^{\frac{1}{1}}}{T^3}\ \text{for a definite time}$$
$$C\mathcal{E} = \frac{mm^2\ mg^{\frac{1}{1}}}{T^2}$$

$$\text{Force} = \frac{mm\ mg}{T^2}$$

$$\text{Work} = \frac{mm^2\ mg}{T^2}\ T = C\mathcal{E}$$

Joule's equivalent is of the same denomination as work

$$\frac{mm^2\ mg}{T^2},$$

so it seems wrong to place it ~~opposite~~ not in an equation which has on the other side $\frac{mm^{\frac{3}{2}}\ mg}{T^2}$

$RE = 10^{12} \frac{mm^2 . mg}{sec^2} = C^2 R$

Joules equiv = see p. 162

$4160 \times 10^4 \frac{Centi^2 . Gram}{sec^2}$

$1 \frac{cm^2 Gm}{sec^2} = 10^{12} \frac{mm^2 mg}{sec^2}$

1 Gram of Sn will heat 769 or 7347 H_2O 1 deg C.

1 mg 769 mg H_2O

Joules equiv. does not depend of the denomination of the Mk since it is changed in both the unit to be raised of the material and of the H_2O.

— so that in changing from the $\frac{cm^2 Gm}{sec^2}$ the change of the cm. to mm. is all that counts.

∴ Joules equiv

= 4160×10^6.

— German unit of current deposits
One of Weber. unit = 0.1 a Weber but to Ag = Weber deposits .03411 mg in one sec
and

Water Daniells

$CE = 76.9$ or 734.7×10^{-3411}

$\times 4155 \times 10^{6}$

$= 1.09 \times 10^{11}$

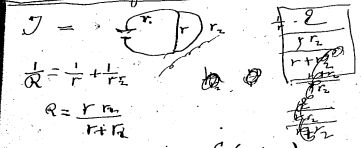
This seems to be all wrong since it would be of 10^{12} $\frac{mm^2\ mg}{Sec^2}$ or the unit of a Weber over an Ohm

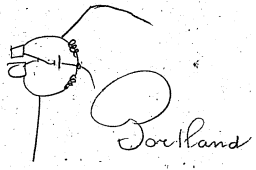
July 15.

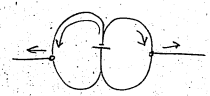
The EMF of a Daniells increases as the solution of Zn. is diluted about 2% chiefly.

Wiedemann Vol I P 250

Amalgamated Zn. has greater less EMF. than unamalgamated.







$R = \frac{r r_2}{r + r_2}$ =

$c : c_2 :: r_2 : r$

$C' = \text{Total}$ $\quad \vartheta_1 = \frac{\mathcal{E}(r + r_2)}{r r_1 + r r_2 + r_1 r_2}$

$c + c_2 = C'$

$c + c_2 : c_2 :: r_2 + r : r$

$c_2 = \frac{r C'}{r_2 + r}$

~~$\vartheta_2 = \frac{\mathcal{E} r}{r r_1 + r r_2 + r_1 r_2}$~~

$\vartheta_1 = \frac{\vartheta_2 (r + r_2)}{r}$ $\quad r_2 \gg r$

$\vartheta_1 = \frac{\vartheta_2 r_2}{r}$

174. Aug 6 1919

Tested Latimer Clark's standard cell by

Remarks. ———

He speaks of washing the Mercurous Sulphate until the yellow is completely removed. Lamson washed the white powder obtained by precipitating Mercurous Sulphate from the Nitrate by means of Sulphuric acid. It became more and more yellow instead of white - a trace of Sulphuric acid would instantly restore it to whiteness. He prepared the Sulphate as he did after the manner described by Mr. Clark, by boiling Hg in H_2SO_4

This ——— after 175

repeated washing gave a greenish ppt which was made white by addition of a trace of H_2SO_4. Mr. Clark distinctly says no trace of H_2SO_4 must be present on account of its altering the E. M. F. but if he procured a white powder after many washings it is proof that ~~none~~ some H_2SO_4 was present.

He speaks of the alteration due to temperature as being .055 of one per cent above 15.5° C and .08 below 15.5° C

which is ~~[illegible]~~ ing that taking the statement literally is most wonderful ~~[illegible]~~ that at an ordinary temperature there should be so sharp a change, on taking the statement scientifically that it means to be had measured the E. M. F. at 0°, 15.5° and 100° C and that the numbers express simply the the difference divided by the number of degrees between the ~~[illegible]~~ the figures given, it is extremely true. An error of 1/2 per cent may be introduced into calculations by

this ~~[illegible]~~ and I had five c.c. Cl. made and found that they ~~[illegible]~~ 2 to 3 per cent ~~[illegible]~~ the ~~[illegible]~~ ~~[illegible]~~ glycerides seem to cling in the pores and any tendency out also forces the mercury through the pores tending to ~~[illegible]~~ the ~~[illegible]~~ ~~[illegible]~~ very ~~[illegible]~~ and ~~[illegible]~~ and ~~[illegible]~~ The standard cell is much better, easier ~~[illegible]~~, more constant, and a more natural unit.

F. R. [illegible]

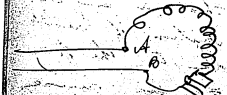
18 Oct 11, 1879

Regulation

To make a ten Ohm lamp equal to 100 Ohm

The current may be made to divide by a commutator in the cellar, revolved by an additional circuit so as to turn all the time

With a motor put in the circuit ~~that same current~~ If this is so arranged nine lamps are put in circuit with the motor in each house



a regulation may be effected, but the economy would be the same as if a resistance were not inserted when the motor was taken out. The Reason the same amount of energy must be given off from each lamp by the same current so that the drop of the E.M.F. must be the same from between the two extremities of the lamp, so that when was the total fall must be the same for the whole circuit ~~was 100 Volts~~ 900 Volts from A to B. If the law holds true that in any circuit the distribution of work is proportional to the fall of the E.M.F., as since

motor the same current is
~~the same~~
the same when the motor
is running as when the
~~there~~ there is only resis-
tance in the circuit.
~~and~~ the same fall of
E. M. F. will occur around
a lamp to denote the same
amount of energy given
off, that is 10 Volts, then
the 90 Volts fall in
the remainder of the cir-
cuit will represent the
same work given off
in either case.

Mr Edison proposes to have 153
in the cellar of the house an
arrangement ~~to~~ with say
10 commutators each one
connected with a lamp.
If each lamp is on 1/10 of the
time it will receive 1/10 of
the current that it would
if it were on all the time
that is a ten Ohm lamp
would take the place of
a hundred Ohm lamps
with such an arrangement.
This commutator must have
the same number of breaks
as there are lamps in the
house. If all the lamps are
on there will be no
spark.

In this way the general average of the house is taken. That taking a large number of lamps only 1/10 of them will be out at once.

If there are 1 Ohm conductor for every 10 lamps 1/10 of the energy will be lost in the conductors when all the lamps are on and a ~~proportional~~ ~~part~~ less proportion when less are on, for this each lamp will have the Co. for the neighboring houses & use.

5.5 Ohm
a stick 8 inches long
.060 inches diameter

5.5
36
330
165
1980

2/16
4

8 .010
.038
8
.248 surface

8 inches .010

10^8 Volt $= 10^5$ Meter Gramme / Sec.

$\frac{10^5 \times 2}{10^2} = 10^3$ Meter Gramme / Sec.

Table Ref Engg.

Thomsen p 419

68,376 heat units

16 grammes O

2 " H

68,920 Favre & Silbermann

1.44 Daniells cell

Cl. equiv. 35.5

Na. " 23

Dissolution Hydrogen Chloride

17,314 heat units

114,380 heat units developed in the production of 2 Grms of H by the action of Na

on a dilute solution of ~~HCl~~ Hydrogen Chloride

Sodium hydroxide combining with H. Cl gives

27,490 heat units

HC in dissolution with K_2O

17.314 heat units

68.376

An Erg is the unit of work a dyne the unit of force is the force which acting on one gramme for one second produces a velocity of one centimeter.

The unit of work is that which is required to overcome a resistance of a dyne over a centimeter.

In Paris the dyne is equal to the weight of $\frac{1}{981}$ gramme an erg the work required to raise $\frac{1}{981}$ gramme 1 Centimeter high.

$\frac{1}{2}$ Erg = $\frac{1}{981}$ Gr Centi

2.0083
0.98093
2.8676

1000 Ergs = $\frac{1000}{981}$ Gr Centi

= 1.019 Gr Centi

1,000,000 Erg = 1.019 Gr Centi

Meg Erg = 1.019 Gr Metre

= .01019 Kilo Metre

= .01019 X 7.23 Ft. Lbs

= .0737 Ft. Lbs.

This looks all right but does not seem to be so.

Erg mine 1.000,000,000 Ergs

= 1,000 Meg Ergs = 73.7 ft. lbs

10	·0737
100	·7370
1000	73·7000

Pickering says that in an Erg mine there are 7.46 Horse powers or that an Erg mine or that

7.46
33000
22380
2238
246,18000 ft lbs

Meg Erg = 246 ft lbs

Foot, lbs. in Meg Erg

73.7 Calculated

~~346.~~ Pickering

Mechanical equivalent heat

1390.8 ft lbs

Gr ~~degree~~ C°

1390.8 ft lbs 3.1432

33.000 4.5185
7.46 0.8727
3.6458

4420 ft. lbs

Pickering say it takes 7.46 to make 1000 Meg Erg or 1 Erg 9

4.42 foot lbs 1 Meg Erg

10' 1 Erg
1.0 Erg 1.00

425 G. M.

1390.8 ft lbs

3.1480.
7.1407

2.2837

1390.8 ft. lbs

3.1430
1.4840
4.62702 Centi lbs

42340

422.40 Kilo Metres
Gram
42240 Gramme Metres

4222 Gramme Metre

42240 Gramme Centi

4.6257
2.9912
7.6169

41400000.

41.4 Meg Ergo

422.4 2.6257
41.4 7.6169
1.0088

10.2 Gramme Metre

.0102 Kilo Metre
723
.0102
1446
723
.07346 foot lbs.

Jenkin

One absolute C.G.S. (Engl.) unit of work

= .00101 95 C.G at Paris

1000000 Mgs. 1019.5000000 C.G

Mag Grd = 1019.5 C.G

= 10.195 m G

= .01019 Kil. Meter

= .0737 ft. lbs

6.00

44.8200

50

2200

.0737

50

3685.000

500

60

30000

.0737

2000000

22111.0000

2,211 ft. lbs.

500 Megs Erg per second

is 2,211 ft. lbs per minute

Schwendler

says a candle from

2,211 ft. lbs per minute

Gr M.S = .10129 G.M

Gr C S = 10000

10000 Gr C S = 1 Gr M.S

∴ = .10129 G.M

1 000000 Erg = 10.129 G M

Meg Erg = .10129 K M

= .6737 ft. lbs

6.751.000 one pound of H2O

51,359,000 ft. lbs. pound H

9 5.751 in one pound of H2O

6.39

6.1172000

.737

60

44.220

3.063.9

1390. ft lbs Mechan Equiv heat Gr C° R

68.376

1390

6153840

194928

68374

9401 8,640 ft. lbs. from the beginning of 16 lbs of O with 2 of H. R

1 lb of H2O

11.502,300 ft. lbs of

in two pound of water

~~one lbs of water heated~~

To heat one pound of water 1° F requires

772.6 ft. lbs.

To heat one pound of water 1° C requires

1390.8 ft. lbs.

To heat one gramme of water 1° C requires

1390.8 ft. Grammes

1 Gramme = ~~1/1000~~ Kilo

1 Kilo = 2.2046 lbs

1 Gramme = $\frac{2.2046}{1000}$

= .0022046

1390.8 ft Grammes

= .0022046 × 1390.8 ft. lbs

3.34333

3.14329

.48662 . 30665

= 3.0665 ft. lbs

3.0665 ft. lbs

33.000
60
1,980.000 Horse power for an hour

6 Horse power of energy to decompose 1 lb of water which will make 1 lb of H and 8 of O

That is to take off make 1/9 lb of H.

~~To take~~ To make

$\frac{35.36}{16} = 2.21$

If it takes the same energy to separate Ch. from ~~H~~ as O from H it would require 6 Horse power to make 2 lbs about or ~~+ lbs~~ 3 Horse power to make 1 lb.

$\frac{196}{35} = 5.3$

Enough to combine with 2.7

$\frac{5.3}{2}$ lbs of Gold.

Theoretical.

22.000 Heat units in the production of H.Cl

68.376 H_2O
22 000
46,376 Cl. O

114.380 formation of Na. Cl with H. from H.Cl in H₂O
114.380
22.000

114.380
68.376
182.756

Sprague gives the No of foot lbs developed by the "gr. equiv" of Na in combining with Cl. as 18,764

a pound requires

6,764 × 7000 / 35.5

3.84510
8.44977
4.27332
6.56819

3,700,000. ft. lbs

2 Horse power about

183.756 mills

35.5 lbs C with one lb of H.

183.756	5.26411	
1390	3.14301	
comp 35.5	8.44977	
	6.85589	

7,120,000	6.85289
1,950000	6.29627
	.56012

3.6 H.P. required to make 1 lb. of Ch in one hour

Bait. Engg.

4.802	6841
7000	7000
33,614,000	53,687,000

1390
22000
2780000
278
30,580,000

183,756

35	1.54411
23	1.36017
	.28224
	6.56881
	6.85505

7,000000 ft. lbs Sprague

S Sprague

Picturing rays

1 litre of air weigh 1.2934

In a pound there are

453.59 Grammes

$\frac{453.59}{1.293} = 350.7$ litres

$= 398$ quarts $= 99.5$ Gallons

---

1 litre = 1000 CC.

16.38 CC = 1 cu inch

1 litre $= \frac{1000}{16.38}$ cu. inches

3

8.748579

1.748579

$=$ 61.06 cu. inches

350.7 litres

61.06

254498

1.748579

4.330779

21,420 cu inches

3.237549

1,09823

12.39 cu feet

,36441

2.31 feet on a side

Box

2 ft. 4 inches on a side will contain about one pound of air.

The combination of one ~~part of Na with 35.5 Grams~~ 23 Grammes of Sodium with 35.5 Grammes of Cl. is attended by the liberation of 94.847 heat units.

Watts after Favre & Silbermann

Thomsen 97.690

94.847

~~19.2,53.7~~

96,268

355 Grammes 96,268 Gr. C°

~~1390 ft. lbs~~

1390 ft. Gr

35.5 lbs 96,268 X 1390 ft lbs

96268

1390

8664120

288804

96268

133,812,520 ft. lbs.

133 812,000

355

376,9,000

33000

1,980,000 ft. lbs 1 H.P.

one hour

8.12649

1.55023

6.57626

.57626

.29667

1904 H.P. .27958

Mechan. Equivalent of heat 423.55 Gm. through 1 Metre =

1 Gm. H_2O one degree C.

1 Gm. H_2O 1°C. =

423.55 Gm. M.

7.233 ft. lbs in 1 Kilo Metre

.007233 ft. lbs in one Gm. metre

.007233 ft. lbs. in one Gm. Metre

~~9481~~

96.000 4.98227

423.55 2.62690

7.60917

.007233 .007233

.007233

4,066,000 g. m 7.60917

.007233 $\bar{3}$.

2.679 .00267 lb in Gramme

.373 Kilo in lbs

373. 2.51171

.007233 $\bar{3}$.85932

2.35 .37103

7.60917

7.98020

95,540,000

216 Heat Equiv. 1 Gramme

423.55 Gr M

Gr Kgt

423.55 × 3.281 = 2.62690 × 0.51610 = 3.14300

1390 Gr Kgt

1 lb H_2O 1°C

1390 ft. lb.

27

14 × 14 = 56 + 14 = 196

9.5 × 3.5 = 175 + 105 = 1212.5

12) 196 (16
12
76

13.8 × 3.2 = 5051 / 10102

13.8 × 1.1399 = 2.2798 + 1.1010 = 1.2696

3.7 × .5682 = 1.1364

12 × 2.1584 = 1.1364 = 1.0220

10.5

Motor Equation

$\mathcal{E}_B$ = ~~Strength~~ E.M.F. binding dont

$\mathcal{E}_m$ = E.M.F. Motor

R = Resistance Motor

$\frac{\mathcal{E}_B - \mathcal{E}_m}{R}$ = Current through Motor

$\frac{(\mathcal{E}_B - \mathcal{E}_m)^2}{R}$ = Work on resistance

$(\mathcal{E}_B - \mathcal{E}_m)$ = Fall of E.M.F. on resistance

$\mathcal{E}_m$ = Fall on motor

$(\mathcal{E}_B - \mathcal{E}_m) : \mathcal{E}_m :: \frac{(\mathcal{E}_B - \mathcal{E}_m)^2}{R} : X$

X = work on motor

$\frac{(\mathcal{E}_B - \mathcal{E}_m)\mathcal{E}_m}{R} = X$ work performed

$\frac{\mathcal{E}_B\mathcal{E}_m - \mathcal{E}_m^2}{R} = X$

$\frac{(\mathcal{E}_B - \mathcal{E}_m)\mathcal{E}_m}{R} \times \frac{R}{\mathcal{E}_B - \mathcal{E}_m} = \frac{\mathcal{E}_m}{1}$

The ratio of the work performed to the current is always the fall of E.M.F. due to the ~~contrary~~ E.M.F. of the ~~motor~~. $= \mathcal{E}_m$

$\frac{\mathcal{E}^2}{R}$ = Work

$\frac{\mathcal{E}}{R}$ = Current

Ratio work to current = $\mathcal{E}$

$$\frac{(E_B - E_m)E_m}{R} + \frac{(E_B - E_m)^2}{R} = \text{Total work}$$

$$\frac{E_B - E_m}{R} = \text{Current}$$

Ratio Total work to current

$$E_m + E_B - E_m = E_B$$

That is the total work used by a motor is proportional to the E. M. F between the binding posts

That is in the case of a motor or a lamp the ratio of work to current is always a constant so that a meter will measure the energy

consumed

The ratio of the work consumed by resistance is to that consumed by the armature is constant — the fall in the total resistance.

E. M. F.

The work given off by the motor is $\frac{(E_B - E_m)E_m}{R} = W$ $\frac{E_B - E_m}{R} = C$

so that $W = C E_m$

Nov. 17 1879

J. R. W. Starr

Fall in E.M.F. due to lamps.

~~Let~~ Suppose to

Let R_l = resistance lamp

R_c = " in conductor

$\mathcal{E}$ = E.M.F. of machine which is kept constant

n = number of lamps in multiple arc

X = E.M.F. at extremity of lamps

$$X = \mathcal{E}\frac{\frac{R_c}{n}}{\frac{R_c}{n}+R_l} = \mathcal{E}\frac{R_c}{R_c+nR_l}$$

$$= \mathcal{E}\frac{nR_c}{R_l+nR_c}$$

R_m = Resistance motor

$\mathcal{E}_m$ = E.M.F. of motor

$\mathcal{E}$ = E.M.F. Machine Constant

R_c = resistance conductor

X = E.M.F. at motor

n = no motors

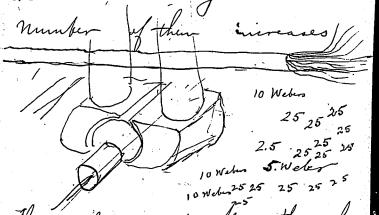
$$\mathcal{E} = \left(\mathcal{E}-\mathcal{E}_m\right)\frac{R_c}{\frac{R_m}{n}}$$

$$= \left(\mathcal{E}-\mathcal{E}_m\right)$$ writing ~~omitting~~

$\mathcal{E}_m$ not constant ~~working~~ that's the rub

$\mathcal{E}_m$ Emotor

The "Electromotive force of the emotor changes as the number of turns increases



That is less current flows through each one and they [illegible] less taking up less work

The energy used in work in a motor is

$\mathcal{E}_B$

The energy in useful work

$$\frac{\mathcal{E}_B \mathcal{E}_m - \mathcal{E}_m^2}{R}$$

$$\frac{(\mathcal{E}_B - \mathcal{E}_m)^2}{R}$$

$$\frac{\mathcal{E}_B \mathcal{E}_m - \mathcal{E}_m^2 + \mathcal{E}_B^2 - 2\mathcal{E}_B\mathcal{E}_m - \mathcal{E}_m^2}{R}$$

$$\frac{\mathcal{E}_B^2 - \mathcal{E}_B\mathcal{E}_m}{R}$$ Total work

W

$$\frac{\mathcal{E}_B^2 - \mathcal{E}_B\mathcal{E}_m}{R} \quad \frac{\mathcal{E}_B^2}{R}$$

226

E = Electromotive force
Electromotive force
Electromotive force
Electromotive force
Electromotive force
Electromotive Force.

E·M·F.

227

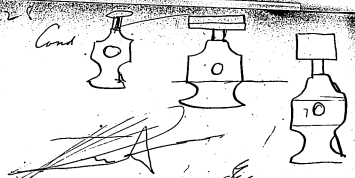
80
80
6400
44
27 6 00
25 60 00
100 | 28 16 9 | 2816
200
816
800
166
100
600

150 | 2816.00 | 18.70
150
1316
1200
1160
1050
1106

Portland

Jan

Cond



$\mathcal{E}$

$\frac{\mathcal{E}_m}{\mathcal{E}} = \frac{\mathcal{E} - \mathcal{E}_m \left(\frac{R_c}{R_m}\right)}{\mathcal{E}}$

$\frac{\mathcal{E} - \mathcal{E}_m}{\mathcal{E}} \frac{R_c}{R_m}$

$\mathcal{E} - \mathcal{E}_m \frac{R_c}{R_m} \frac{R_c}{R_m} \frac{R_c}{R_m} \frac{R_c}{R_m + R_c}$

$\frac{R_c}{R_m} \frac{R_c}{R_m} \frac{R_c}{R_m} \left(\frac{R_c}{R_m}\right) \frac{R_c}{R_c}$

multiply

Motor

$\mathcal{E}$ Lamps

$\mathcal{E} \frac{\frac{R_c}{n}}{\frac{R_L}{n} + R_c} = \mathcal{E} \frac{n R_c}{R_L + n R_c}$

Lamps

Lamps

$\mathcal{E}$ R_c

Lamps

Lamps Lamps

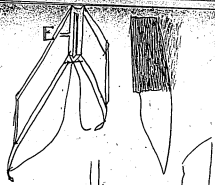
Lamps

Lamps

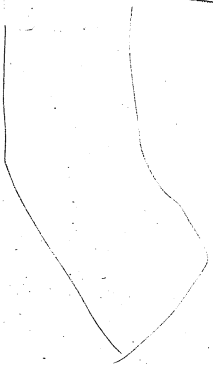
$\frac{R_c}{\frac{R_L}{n} + R_c}$

Lamp

Motor



1 Mile



600 Ohm
150 Ohms

.004
.008 2600
.016
.032
2600
2600

375
9.87
2.34

16) 1000 (62
96
40
00 4) 62
15.5) 60
16

250

~~$175~~ $175 $175
~~$175~~ $176 $175

4 hours
3 hours each day

365
3
1095

1000 hours
5000 feet
5.00 feet per year per burner

$2.50

80,000

250 | 8500 | 34
750
1000 | 102

3%
10 000
Conductor

$3.40
1.50
5.00
$13.42

$34
$15

$1.02
1.50
5.00
1.00

$13.42
.85
$219

217

13
5
.85

50 cts per thousand

~~$2.00~~

60 3.00

$3.40
1.50
1.02
1.50
3.00
1.50
5.00
1.00

$17.92

1.8

250 | 450
250
1800

3 | 150

3 | 150

1650
1320
330
165
165

1650
1320
330
165
165

1650
1320
330
165
165

~~9 90 cts~~ 36,500

365 ×100

~~4 hours a day~~

5 hours each day

average burner on

~~maximum~~

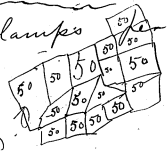
365 / 5 / 1825 hours

1800 / 5 / 360 H

1800 hours

1800 hours a year

8 lamps to H. P.



Cost Horse Power

$34.

$15

$0%

~~Boilers~~ Engines

Boilers

~~Engines~~

$40

50
50
2500
4
1000

3 cts an hour per H. P.

6
18
5
90 cts

We shall have ten lamps per horse power indicated — easily 100 ohms each

~~Cost of Generator per horse power~~

$34	Engine	700 per horse power
$15	Boiler	$37.000 per horse power
		$37.000
$3.40		per horse power
$1.50		
$4.90	Investment Boiler & Engine	
	per horse power	$25.000
		$25.000

2 Dynamo Machine

60 lights per machine

$180. a machine $26.000 $25.000

$3.00 Investment Dynamo

Conductor

$5.00 per lamp

$12.90 Investment per lamp

Depreciation

$10 a	Engine	.10
1.5 a	Boiler	.15
10	Dynamo	.10
	Conductor	.05
		.45

1800) 1.74 .0096 1.29

1.7400 .0006 $1.74 10%

.10	1800	1.74 00 (96 cts.
.15		16200
.15		12000 10%
.05		10800 10%
.45		1200 10%
Brushes		$25.000 $25.000
Commutator		
Conductor		$25.000 $25.000

5 96 cts per 5000 feet

~~.0019~~ cts $25.000 $25.000

20 cts per 1000 feet

$2.000 per 1000 ft investment

34 cts per 1000 feet

paying 10% on plant and depreciation

1000 ft

2 cts per H.P

2 cts per 5 feet

200
40 cts. per 1000 feet

40 cts. per 1000 feet 1000 1000 1000 feet

2 cts per H.P. $ $

$180 $ $ $

2 5 2000 3 000000 3000 $7.50 $7.50

$7 $7.50 $7.50 $7.50 $7.50 $7.50

60 | 4.50 $22 $22 $22 $22 $22

$7.50 $22 a hour

.140

$22 $22

$20 $20 $22 $300

$20 $12

$300

A $350 $350 $400 $400 $400

$5.00 $400

35 M a 1000

45 M

$80 65 M a 1000

2 5000 25 c

250

300

$400 900 $1000

$360000 $90

50 cts. a 1000

3 000000 50 cts. for

30 000 cts 1000

= 6 per H. P.

700 X 200 feet

A 350 feet
7
2450
2
590 feet

30 Houses

.0047 × 30 = .1410
10.5 lbs × 30 = 315.0 lbs

G 15 Houses 460 feet
2
920 feet

.0075 × 15 = 375
75
.1125

26.5 × 15 = 1325

B 30 houses
350
avenue 100
245
695
2
1390 feet

.0112 × 30 = .3360
60 lbs × 30 = 1800 lbs

300 150
600
1200

F 30 Houses
350
50
140
540
2
feet 1080

.0087 × 30 = .2610
34.5 × 30 = 1035.0

C.C' 30 Houses
Corner
350
50
200
75
245
920
2
1840

.8940
105.8 × 60 = 6348.0

G 30 houses
350
50
200
75
140
815
2
1630

.6132 × 30 = .3980
83 × 30 = 2490

262

DD' 60 Flames

350
50
200
75
200
875
2
1750

·10181
60
10860

156
60
9360

675
245
1120
2
2240

H 3 w lights

875
140
1015
2
2030

·0172
30
·5260

142
30
4260

EE' 3 w lights

1075
245
1320
2
2640

·0212
30
·6360

217·8
30
65240

Lamps

A	300	·1410		
J	150	·1125	315	
B	300	·3360	132	
F	300	·2616	1800	
CC'	600	·8940	1095	
G	300	·3960	6348	
DD'	600	1.0560	2490	
H	300	·5260	9360	
EE'	300	·6360	4260	
	3150	43885	32324 Cu	

3150) 32324 (10.2
3150
8240

10.2 lbs of Cu per lamp

10.2
30
3.06 for Cu.
5.00 with box

$20 $50 a year

$12.50 per quarter

3 hours

5 4 1/6 60 each per month

3 1/2 hours

5 1/2 hours

365 1 hour a day

365

730 2 hours

365

1095 3 hours

365

1460 4 hours

360

1406 5 hours

365

2190 6 hours

365

2555 7 hours

730
365

365
3
1095

Dynamo Work

100 $200

500 feet $4.00

Engine & Boiler 5.00

Conductor 5.00

Building 5.00

19.00

Burners Meters &c 1.00

$20.00

Interest $2.00

Depreciation $2.00

$4.00 a year

4 hours

.277

55 cts per M

1440) 4000 (2.77 cts per hour
2880
11200
10080
1120

H. P. 1

Coal under boiler

$5.00

3 lbs.

3 / 2240
746 H. P.

746) 50000 (.67
4476
5240

.67 cost steam per H. P

$ per H. P.

.084 cts per lamp per hour

200
16800 cts per M

10000 lamps one station

50000 M
4
200 M per day

2 Engineers 4
2 Firemen 12
4 Wipers 8
2 Regulators 4

200) 2800 (14 cts

$28

165 Wanel

85 cts per M
16.8
$\$$
85.18 cts per M paying
10% on capital 10% depreciation
18 per H. P
$5.00 for conductors
4 hours a day
five feet
10000 lamps a station

16.8 $\$$ per H. P
14.
4 3 08 cts in holder
77
23.1 cts

Dynamo 245

$200 8 per H. P
60 lights 1/10 H. P.

1/10 H. P 60/204
1/20 $3.33 per lamp Dynamo

Wear and tear 5%
1.665

Engine 34 per H. P
$4.125 per lamp

Boiler $15.
$1.87 per lamp

Conductors	5.00	
Lamps &c	1.00	3.33
		4.12
		1.87
		5.00
Cap		$14.32
		5.00
Building	$20.32	19.32
		1.00

Depreciation

3 ~~10%~~	on Engine	~~.124~~
5 %	on Dynamo	~~.166~~
10 %	Boilers	.187
2 %	Conductors	.110
10 %	Lamps	.110
Taxes & Insurance 5 %		.50
		1.177

1.17
2.03
3.20 per kwmer per year

3 hours a day

1075) 3200 (.3 cts
3215

1075) 11175 (109
10 75
9500
200
3
60 cts per M

216 cts

4 hours each day

1440) 3200 (2 .23
2880
320 : 200
4600

46 cts per M

5 hours a day

1805) 3200 (1 7
1805
13950 : 20

34 cts per M

6 hours a day

2170) 3200 (1 4
2170
10300

24 cts per M

1440) 11176 (7 1
10080
1620
142

1805) 11200 (6 5
10830
@ 700
P
13

272 10000 lamps

16.6 cts per M

coal at $5.00 under timber

page 267

labor $28 per day

A day	3 hours	$9.33	per hour
	4	7.00	"
	5	5.60	"
	6	4.66	"

10000 lamps

3 E

3 M per hour

3 hours 50) 9.33 (18 cts per M

50

433

4 hours 14 cts per M 273

5 hours 11.2 "

6 hours 8.3 cts

Oil waste 4c

3 cts per M

3 hours
60.
16.8
18.
5.
99.8 cts per M
39 cts in holder

4 hours
46
21.8
14
81.8 cts per M
35.8 in holder

5 hours
34.
21.8
11.2
67.0 cts per M
33 cts in holder

6 hours
28
21.8
8.3
58.4 cts per M
29.3 in holder

Management

1/2 of 28 = 14 a day

8

$100.8

Cost with Assortment
39
21
60 cts per M

88 cts

3 men 1 hr.

35.8
14.2
50.0 cts

72.7 cts

33
13
46 cts

62.3 cts

176

15.10

3650
5
18.250

4,000,000

40000000

12
50
760

60 | 16 00 (
#26

760 | 16.000 (2.2.3
1520
1800
1520
2800

277

80 | 100 (
#12.5 Bottom set
12.5 Ground and Flash
#25.00 Bricking on

4.25
85
4
330

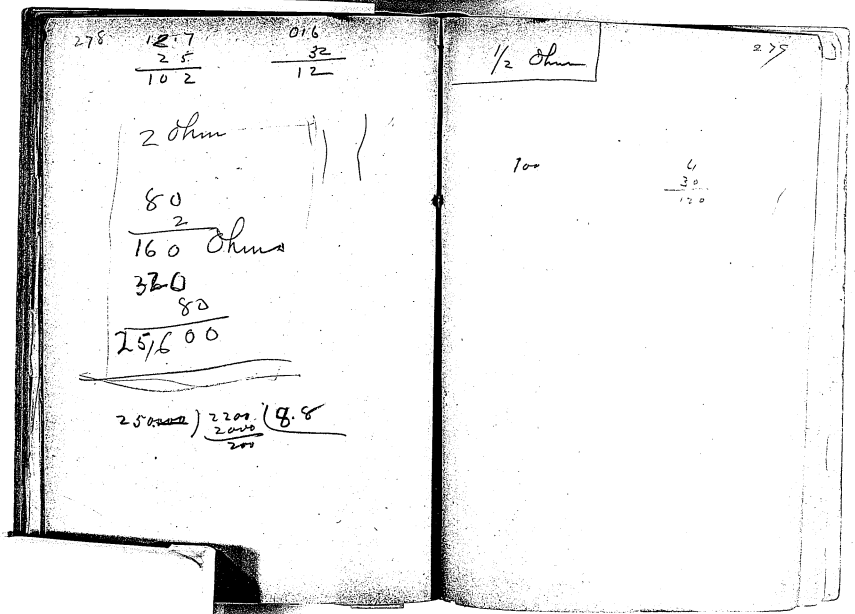
.435
87
84 6

5 | 10.10
202
6

802
320
130

165
33
132

167
334
1386


278
12·7
2 5
1 0 2
0·16
32
12
2 Ohm
80
2
160 Ohms
320
80
25600
250 mm) 2209. (8.8
2000
209
1/2 Ohm
275
100
4
30
120

24

3 lbs per N. 10

10
30
150 as Ans

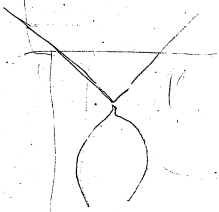
3
3
441
5
120

44.3 per 1000

3.00 / 2240 | 3.000 (.00134
2240
760
6720
8400

.00134
44.3
2

218 = 20



2240 | 5:000.000200
4480
20000
44.3
.0022
.0886
2

Menlo Park Notebook #18 [N-79-01-12]

This undated notebook was probably begun prior to April 8, 1879. The entries are by Edison and Francis Upton. Included are a series of notes by Edison on alloys for special composition bars. These appear to be the bars that were used in the thermoelectricity experiments recorded in Menlo Park Notebook #21. Other material includes notes by Edison on platinum, coal heat, and chalk buttons; a series of sketches and notes by Edison that appear to be related to the telephone; and drawings by Upton of generators. The book contains 282 numbered pages.

Blank pages not filmed: 94-121, 124-153, 172-257.

1110 18

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[illegible]

[illegible] N.Y.C.

_____, 189_

Wire 3½ 1

1 — 10½ = '07
2 — 12½ '09
3 — 13½ '09
4 — '09
5 — '09
6 — 9
7 — 9
8 — 9
9 — 9
10 — 9
11 — 9
12 — 9
13 — 9
14 — 9
15 — 9
16 — 9
17 — 9
18 — 9½
19 — 9
20 — 9
21 — 9½
22 — 9
23 — 9
24 — 9
25 — 9

26 — 9
27 — 9
28 — 9
29 — 5½
30 — 9
31 — 9
32 — 9
33 — 9
34 — 9
[illegible]
[illegible]
[illegible]

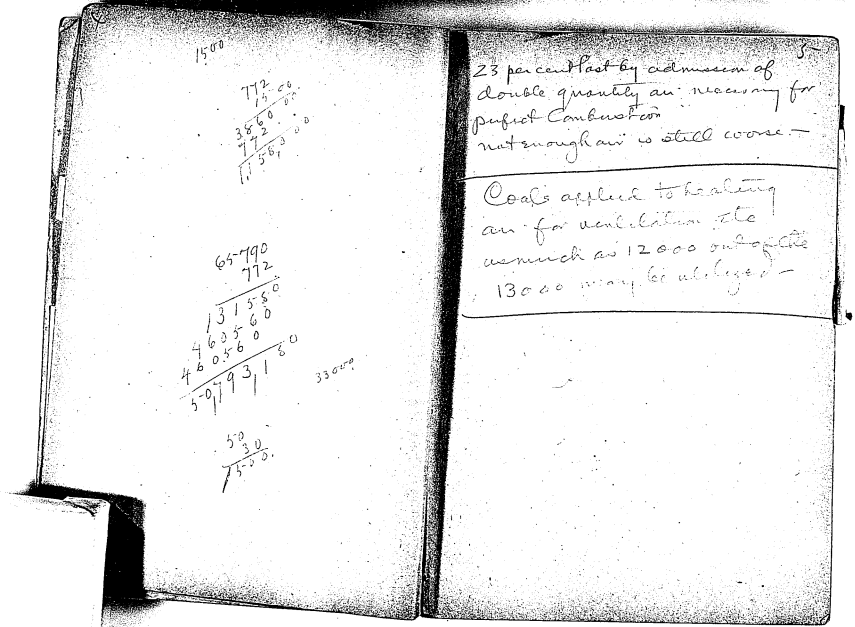
Platina is found in many instances in galena – Vide Phil Mag p 319 1834. Vol 4

Relation of magnetism proportion to length of the Electro magnet, permanent magnetizations of steel best effected by long Electromagnets – Retchie Phil Mag p. 125 – of 1833

13000, units in 120 –

Distribution of the heat in one pound of coal by an ordinary boiler with internal fire –

Ashes left unburned	650
Lost by air in Chimney	2600
Lost by radiation etc Boiler Stone	1560
Utilized in production Steam	8190
	13000



15[00]

772 · 50
1 5 ·
3856 · 00
772
1 1 5 61 3

65-790
772
13155 0
13355 60
46055 60
460556 0
5-0 | 9 3 1 | 330[00]

50
30
15-0 0.

5

23 per cent Past by admission of double quantity air: meaning for perfect Combustion not enough air is still worse —

Coal's affinity to heating air for ventilation the usemuch as 12000 cubic feet 13000 may be allowed —

Alloys Table A.

Sulphide (proto) Tin. with copper

vary by 10 p.c.

Ortho with metallic — Zinc
Lead
Nickel
Tin
Iron
Cadmium
Aluminum
Sodium
German Silver
Antimony
Mercury
Bismuth
Tungsten

Proto- Sulphide Zinc
also Di — Lead
Nickel
Tin out
Iron
Cadmium
Aluminum
Sodium
Antimony
Mercury
Bismuth
Tungsten

Sulphide of Lead with all the metals and sulphide in Table A

S ~~The sulphide~~ Zinc — sulphide
" Iron "
Nickel "
Tin
~~Platinum~~
Aluminum
Sodium
Iron

Page 1

Sulphide Iron with metallic Copper.

Copper.	10.	Sulp Iron	90
"	20	"	80
"	30	"	70
"	40	"	60
"	50	"	50
"	60	"	40
"	70	"	30
"	80	"	20
"	90	"	10

Sulphide Iron, with Sulphide Copper

Sulphide Iron.	10.	Sulph Copper	90
"	20	"	80
"	30	"	70
"	40	"	60
"	50	"	50
"	60	"	40
"	70	"	30
"	80	"	20
"	90	"	10

Sulphide Iron with Metallic Zinc

Sulphide Iron	10	- Zinc	90
"	20	"	80
"	30	"	70
"	40	"	60
"	50	"	50
"	60	"	40
"	70	"	30
"	80	"	20
"	90	"	10

Sulphide Iron with Sulphide Zinc

Sulphide Iron -	10	Sulphide Zinc	90
"	20	"	80
"	30	"	70
"	40	"	60
"	50	"	50
"	60	"	40
"	70	"	30
"	80	"	20
"	90	"	10

Sulphide Iron with Metallic Iron

Sulphide Iron	10	Iron	90
"	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide of Iron with Metallic Lead.

Sulphide Iron	10	Lead	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide Iron with Sulphide Lead 17

Sulphide Iron	10.	Sulph Lead 90
20	"	80
30	"	90
40	"	60
50	"	50
60	"	40
70	"	30
80	"	20
90	"	10

S

Sulphide Iron with Metallic Cadmium

Sulph Iron	10	Cadmium	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide Iron – Sulphide Cadmium

Sulphide Iron	10	- Sulph Cadmium	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide of Iron with Metallic Nickel

Sulphide Iron	10	Nickel	90
"	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide Iron with Sulphide Nickel

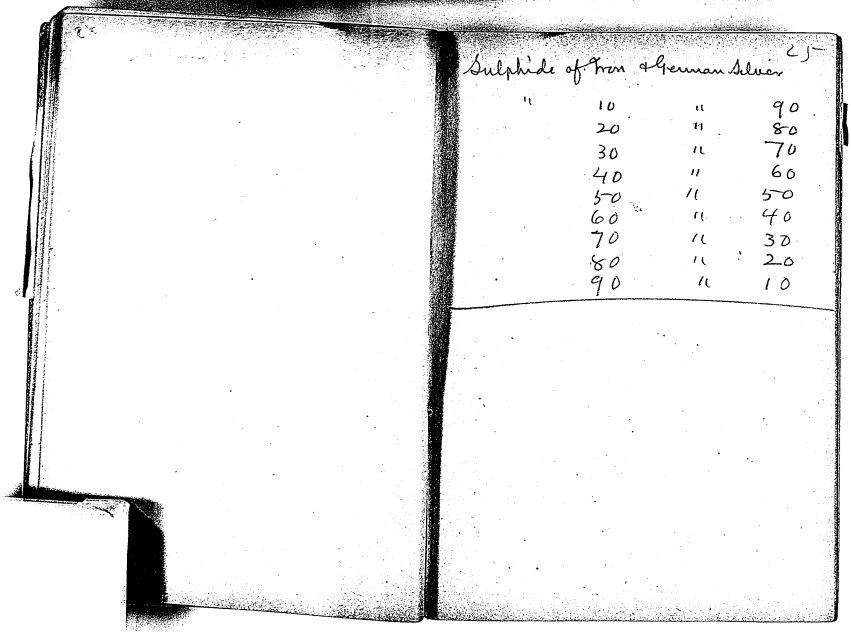
Sulph Iron	10	Sulphide Nickel	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide Iron & Metallic Tin

Sulphide Iron	10	Tin	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide Iron & Proto Sulphide Tin

Sulph Iron	10	Sulphide Tin	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10



Sulphide of Iron & German Silver

"	10	"	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide Iron - parts	Metallic Antimony parts
10	90
20	80
30	70
40	60
50	50
60	40
70	30
80	20
90	10

Sulphide Iron & Sulphide Antimony

Sulph Iron	10	Sulph Antimony	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide Iron & Metallic Bismuth

Sulph Iron		Bismuth	
	10	"	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide Iron & Sulphide Bismuth

Sulph Iron		Sulph Bismuth	
-	10	"	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide Iron & Metallic Tungsten

Sulphide Iron	10.	Tungsten.	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

Sulphide Iron & Sulphide Tungsten

Sulph Iron	10	Sulph Tungsten	90
	20	"	80
	30	"	70
	40	"	60
	50	"	50
	60	"	40
	70	"	30
	80	"	20
	90	"	10

This is one group of alloys with Sulphide of Iron — Now substitute for Sulphide of Iron - Sulphide of Copper & all through the table ~~leaving~~ scratching out Sulphide of Iron — Hence substituting for Copper another Sulphide until the whole of the following list has been made to alloy with Sulphide of Iron

Sulphide Zinc
" Tin
" Lead
Nickel
Cadmium
Sodium
Mercury
Tungsten
Copper
Antimony
Bismuth

This will make 11 more tables if they can all be alloyed —

Tripple alloys

Zinc	Copper	Lead
10	10	80
20	20	60
30	30	40
40	40	20

Lead	Copper	zinc
10	10	80
20	20	60
30	30	40
40	40	20

~~Zinc~~	Lead	Copper
10	10	80
20	20	60
30	30	40
40	40	20

~~Zinc~~	~~Copper~~	~~Lead~~
~~30~~	~~30~~	~~40~~

Zinc	antimony	Lead
10	10	80
20	20	60
30	30	40
40	40	20

Zinc	Lead	antimony
10	10	80
20	20	60
30	30	40
40	40	20

Lead	Antimony	Zinc
10	10	80
20	20	60
30	30	40
40	40	20

Zinc	antimony	Tin
10	10	80
20	20	60
30	30	40
40	40	20

Zinc	Tin	antimony
10	10	80
20	20	60
30	30	40
40	40	20

antimony	Tin	Zinc
10	10	80
20	20	60
30	30	40
40	40	20

also by 10 per ct

Zinc Copper Tin
Zinc Lead Antimony
Zinc Lead Tin
Zinc Antimony Copper

Antimony copper lead
" Tin "
" Bismuth Lead
" Bismuth Copper
" " Tin
Copper Bismuth Lead
" " Tin

Cadmium	Zinc	Tin
"	Lead	Tin
"	Copper	Tin
"	Bismuth	Tin
"	Antimony	Tin
"	Lead	Zinc
"	Copper	Zinc
"	Bismuth	Zinc
"	Antimony	Zinc
"	Lead	Bismuth
"	Copper	Bismuth
"	Antimony	Bismuth
"	Zinc	Bismuth
"	Bismuth	Lead
"	Antimony	Lead
"	Copper	Lead
"	~~Bismuth~~ Zinc	~~Zinc~~ Lead
"	Zinc	Antimony
"	Bismuth	antimony
	Copper	Antimony
	~~Bismuth~~ Cadmium	
	7	

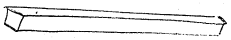
~~Arm Tungsten.~~

Morse combination to be
made -

Special Compositions

Small Bars

Actual size



Bismuth Selenium
Selenium Zinc
Selenium Antimony
Silicon Iron
Silicon Phosphor Tungsten
Selenium, Tellurium
Selenium, Sulphide antimony
Selenium Arsenic
Arsenic Tellurium
Tellurium Phosphor

Large bars Special Alloys

Arsenic	Copper
10	90
20	80
30	70
40	60
50	50
60	40
70	30
80	20
90	10

Arsenic	Iron
10	90
20	80
30	70
40	60
50	50
60	40
70	30
80	20
90	10

Arsenic	Tin
10	90
20	80
30	70
40	60
50	50
60	40
70	30
80	20
90	10

Vary 10 p c

Arsenic & Lead

Arsenic	Zinc
"	Antimony
"	Bismuth
"	Cadmium
"	Tungsten
"	

Phosphor	Iron
10	90
20	80

Phosphor	Tin
"	Zinc
"	Lead
"	Bismuth
"	Antimony
"	Copper

by 10 pc or as far as they will alloy —

Iodine. Copper
" Lead
" Zinc
" antimony
" Tin -

Iron - Carbon
much as steel take -

Iron	Phosphor	Arsenic
80	10	10

$10^1 = 10$

$10^2 = 100$

$\log 10 = 1$

$\log 100 = 2$

$10^{1.27875} = 19$

$\log 19 = 1.27875$

100 L
0
180 L
180 L
50 L
69 L
216 L
218 L
220 L

200 L
178 L
185 L
181 L
50 L
75 L
110 L
305 L
300 L
205 L
310 L
203 L
85 L

70 L
50 L
202
105 L
104 L
102
105 L
104 L
20 L
95 L

26 L
27 L
40 L
76 L
94 L

75 L
195 L
0
225 L
227 L
90 L

11°
200 L
5 L
4 L
2 L
0
1 L
196 L
50 L

50 L
0°
79° L
78° L
75° L
72° L
0°

130 L
131 L
133 L
128
0
174 L
176 L
174 L
50 L
0°
185 L
180 L
179 L
5°
185 L
180 L
175 L
140 L
210 L
206 L
0°
210 L
0°
112 L
110 L
105 L
204 L

264 L
175 L
170 R
0°
50 L
54 L
4°
0°
4 R
50 R
50 L
4 L
22 R
85 L
84 L
4°
170 L
164 L

200 L
0°
194 L
195 L
198 L
195 R
198 L
100 L
100 R
204 R
0°
100 L
200 L
196 L

100 R
0°
100 L
201 L
100 R
102 R
202 L
0°
16 R
18 L
16 R
50 L
0°

22
335 L
4 R
43 R
41
120 L
118 L
140
142
138 L
134 L
4 R
0°
170
170
4 R

51 L
0°
50 L
0°
150 L
135 L
163 L
16 L
0°
225 L
227 L
221 L
4 R
0°
4 R
9 R
4 R
220 L
225 L
260 L
257 L
250 L
248 L
240 L
250 L

245 L
244 L
4 R
0°
15
15
25
25
32
32
2 55 L
260 L
265 L
261 L
260 L
4 R
0°
210 L
205 L
50 R
60 L
60 R
50
34 R
25 R
50 R
34 R
0°
18

345
10 R
20 L
34
100 L
96 L
196 L
99 L
100 L
135
25
38 L
0°
150 L
155 L
157 L
150 L
145 L
150 L
145 L
150 L
4 R
0°
123 L
119 L
118 L
20 L
155 L

62

150 L
148 L
147 L
200 L
200 L
200 L
200 L
240 L
176 L
174 L
214 L

200 L
199 R
4 R
19 R
10 R
11 R
1 R
200 L
195 L
195 L
200 R
200 L
199 R
175 L
180 L
195 L
203 R
203 L
203 L
204 R
50 L
25 R
25 R
L.L.
170 R
150 R
146 R
4 R
170 R

170 R
4 R
148 R
150 R
4 R
146 R
144 R

63

58

.88171

1.76343

3.52686

1.47712
1.47712
2.95424

9.000

837

1.43136
1.49136
2.92272

BY

65

8576 3.
7324 3.

$10^{1} = 10$

$10^{2} = 100$

log 20 = 1.+

log 200 = 2.+

log 2000 = 3.+

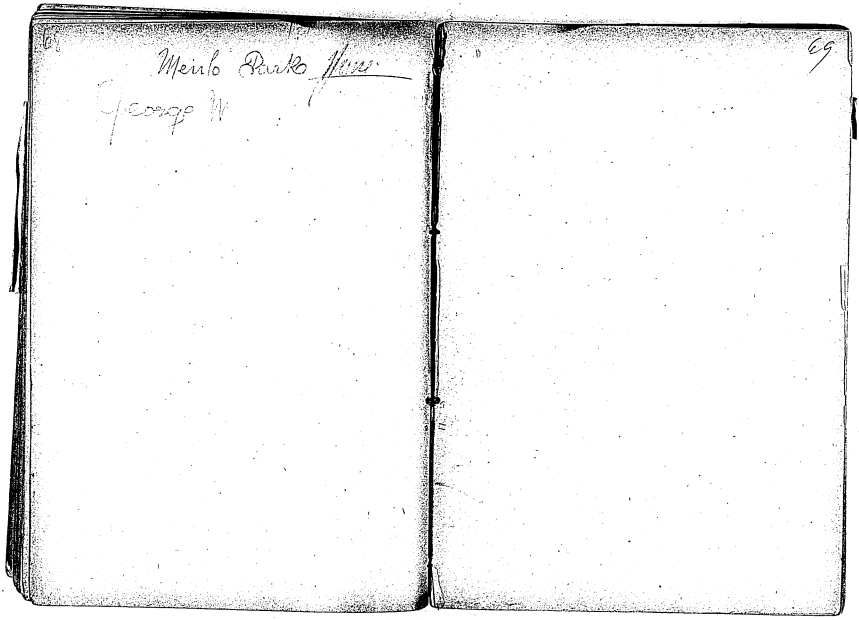
64

65

.91303
1.07068

1.82607
2.03631

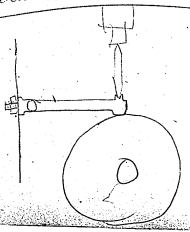
3.65214


68
Menlo Park Notes
George IV
69

3

Chloride Lithia ½ fld oz. 3 Buttons.
Chalk 6 oz
Mercury 18 grains

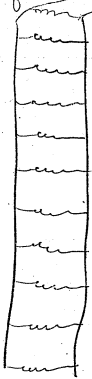
Chalk. 6 oz.
~~Caustic Soda~~ 1 fld oz.
Hot water Syrupy with gelatin



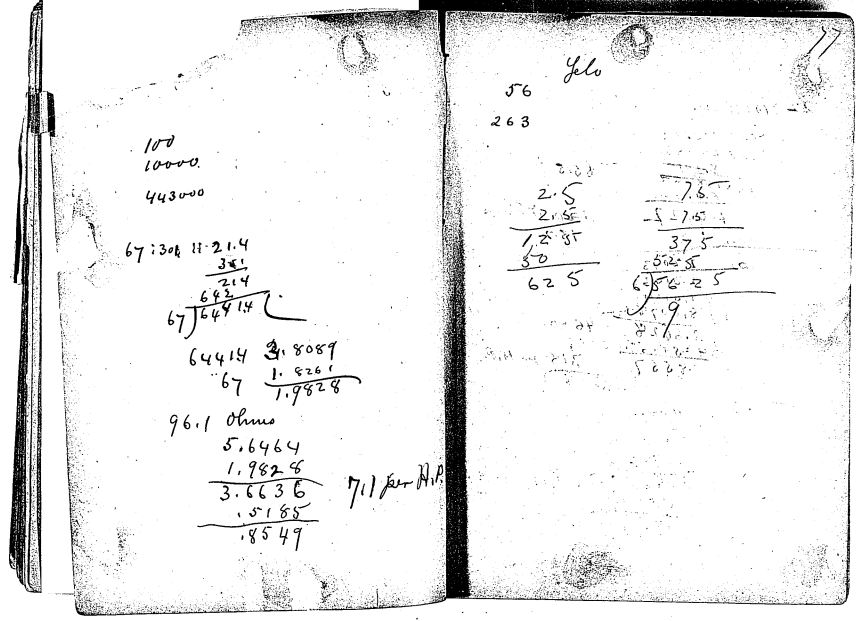
Vulcanized Fibre: Button - Soaked 6 hours in Strong Caustic Soda + afterwards turned -

72

Table of E. M. F.



Pages 72 to 282. "Sketches & Notes on Telephone & Dynamos." Unimportant.



100
10000.
443000

67 | 30811·214
381
214
643
67 | 64414

64414 ÷ 67 = 961.8089
67
1.826
1.98828

96.1 Ohms
5.6464
1.9826
3.6638
.51855
.8549

7.1 for H.P.

Yelo

56
263

2.5
2.5
1.25
50
625

7.5
-5 2 7.5
375
5625
6256.25

19

1

22 : 101 :: 21.4

1.3304
2.0043
~~8.4405~~
~~1.8762~~
8.0575
1.9927 — 65.5

120 Ohms
98.2

101 — 7.0043
2.0043
1.6464
8.0078
3.6628 — 4600
~~4.5185~~
.8557 — 7.18 in H.P.

no 1 does not close, the spring does not catch

8 lbs

12)33,000 | 2,750
24
90
84
60

Minute

1 Gallon — 844 feet

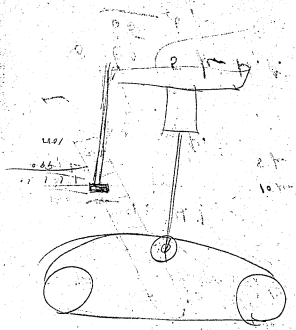
8)2750
344

2 Gallons 172
3 Gallons 114
4 " 86
5 " 68
6 " 57
7 " 49
8 " 44

Hour

60 Gallons

120
180
240
300
360
420
480
540



7.50 7.50 7.50

7.50

7.50 7.50 7.50 7.50 7.50 7.50 7.50 7.50 7.50 7.50 7.50 7.50 7.50 7.50

33) 450 (3 H.P

33

12

10 lamps 8 lamps H.P

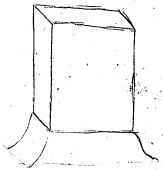
8 60

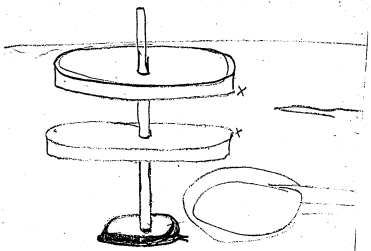
7

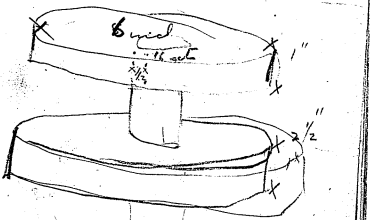
13) 60 (5 lamps H.P

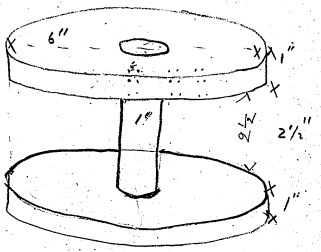
65

6 lamps H.P






1"
2 1/2"



$6 \times 3\frac{1}{7} = 18\frac{6}{7} : 16. = 1\frac{2}{8}$

On edge 16 sets of holes diagonally 1/2" apart 1/4" from edge

122

20 cell = 64

100
100

1.44) 100000 (

1.6
6 1 6
1.44

100

1.44) 144000 (3

1.44) 440000 (307.000
432
800

33.) 307.000 (9.3 H.10
297
100

Thing

123

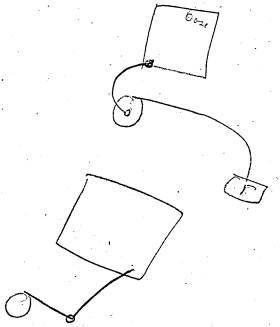
No 5-Ok —

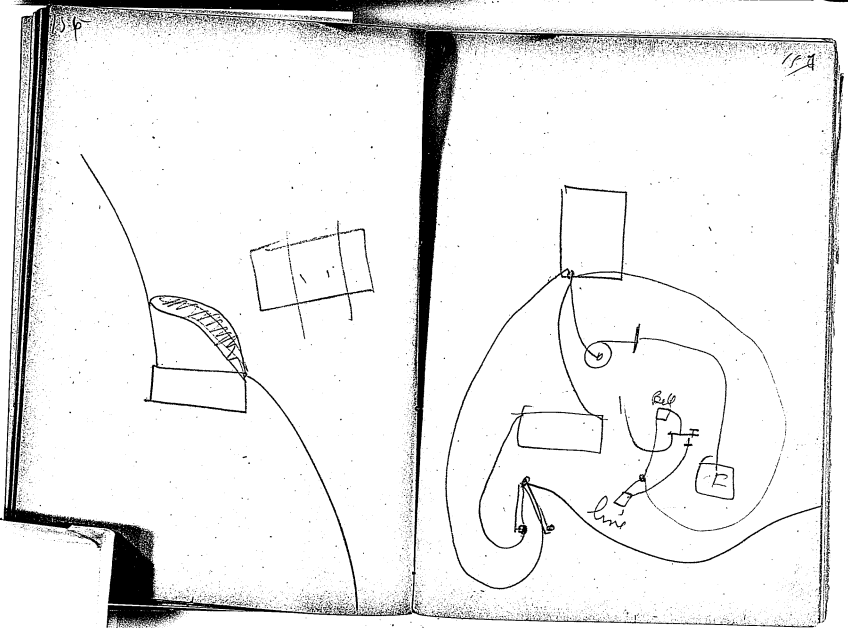
No 1 ~~not~~ bad

No 2. walking at all

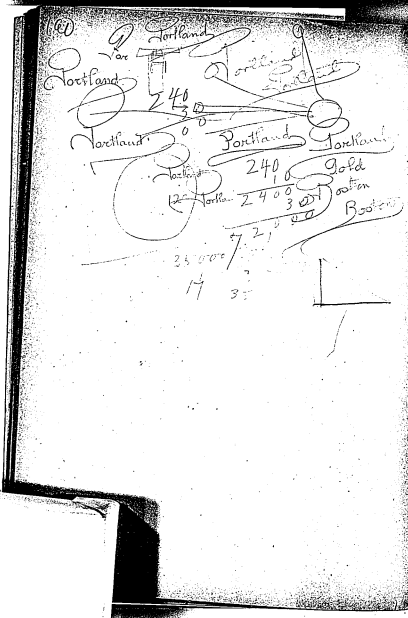
No 3 Wg Embody Entrant

No 4 Wg Embody Ent




Relay
B

base


Portland
Portland
Portland
Portland
Portland
Portland
Portland
240
Portland
2400
3 ply
Portland
Portland
Portland
Portland
Portland
Portland

Round

Ohio

Ohio²

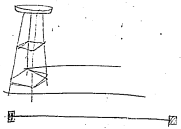
Ohio 50

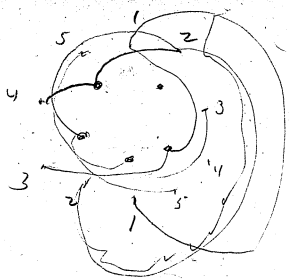
Ohio 100

Ohio 110

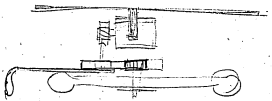
Ohio

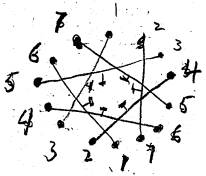
600

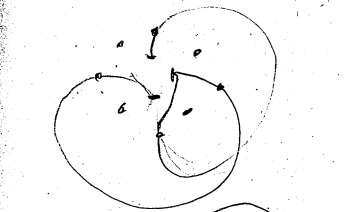


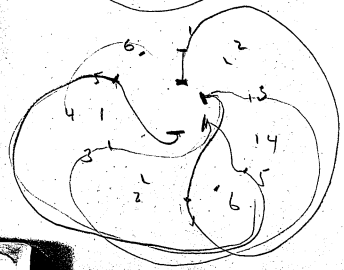

1
2
3
4
5

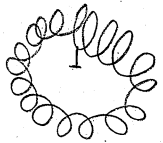
1
2
3
4
5

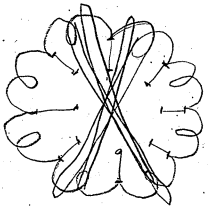


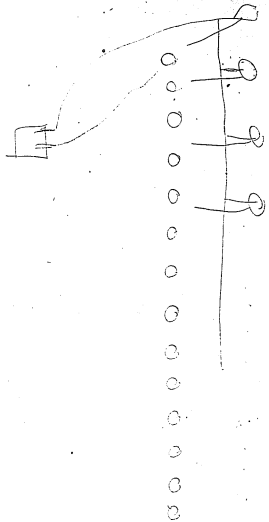


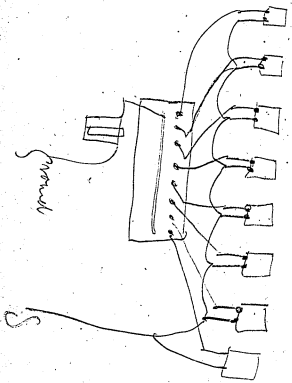


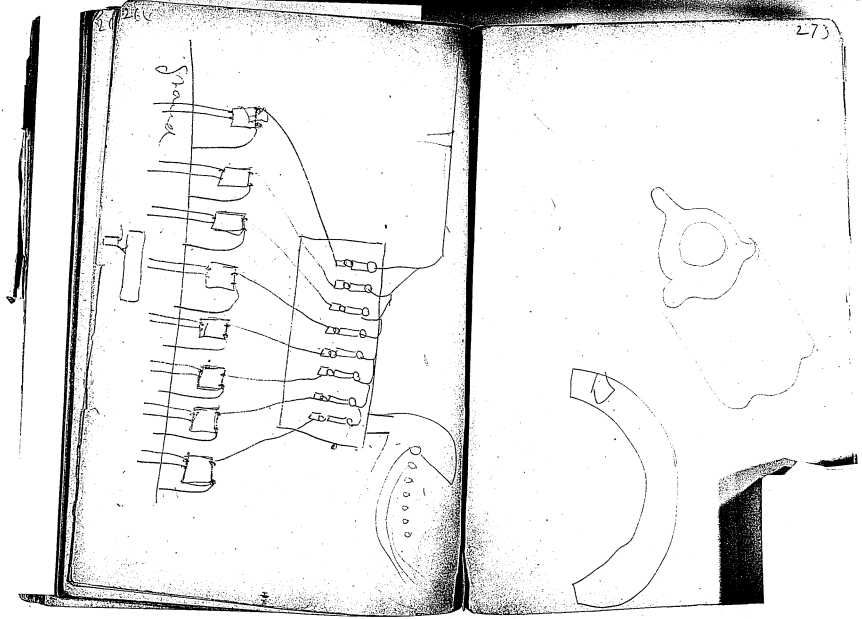

6
1
2
5
3
4
1
3
14
3
1
2
6











1.643453

0.821726
2.979326

1.643453
-3.453753

3.286906
1.322806

.0007141

2.420

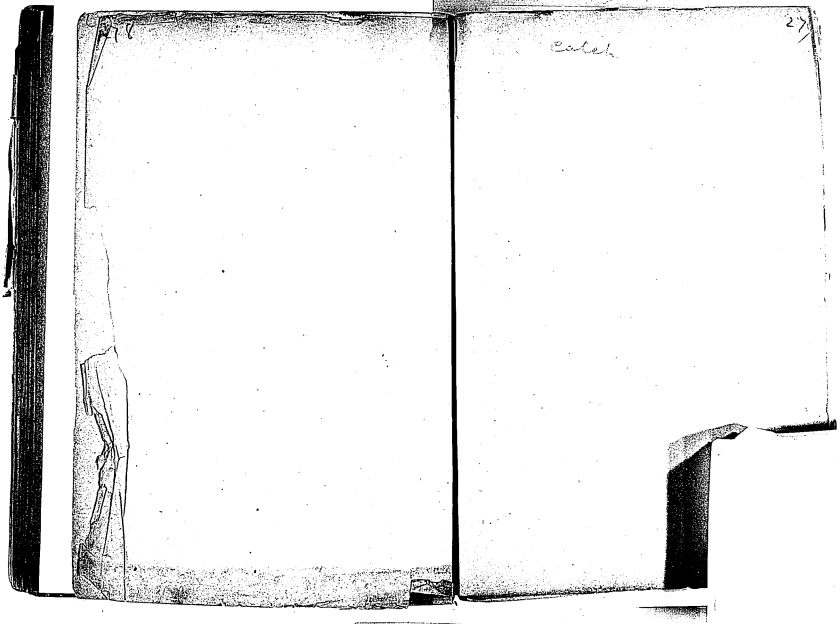
.00[illegible]35

have you a can yo
Love no there al
ah yo have
wer ar you hos

76

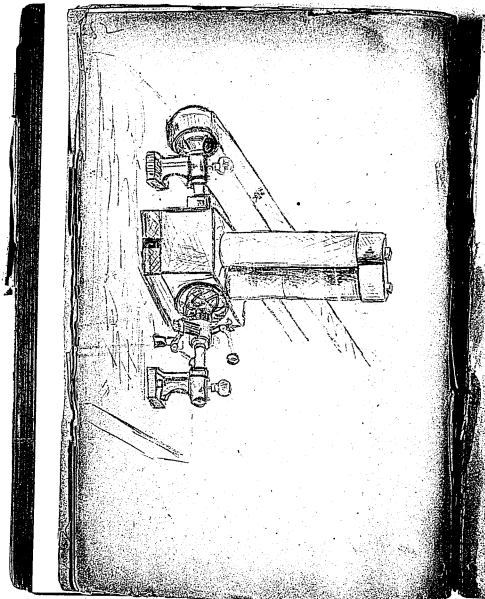
you know a girl
by name of Mary
ann Dumble?

now
Mary ann would be
your
wa
over hear hoping
for y yes



280

$$\frac{\frac{1}{2}\cdot 117\cdot 10}{\frac{1}{2}\cdot 7} = \frac{117\cdot 10}{7}$$



Edison Laboratory Note Book No. 18.

Dynamo.

See Edison Patent:

337,313 (Pat. Oct. 1885.)

225

CATH

1000000000 = 10^9
100000000 10^8
+ 10^7

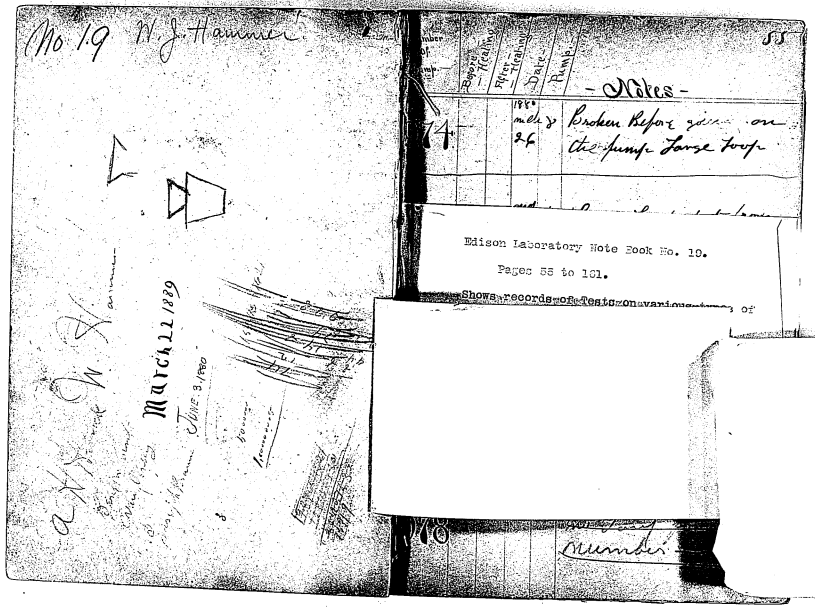
225

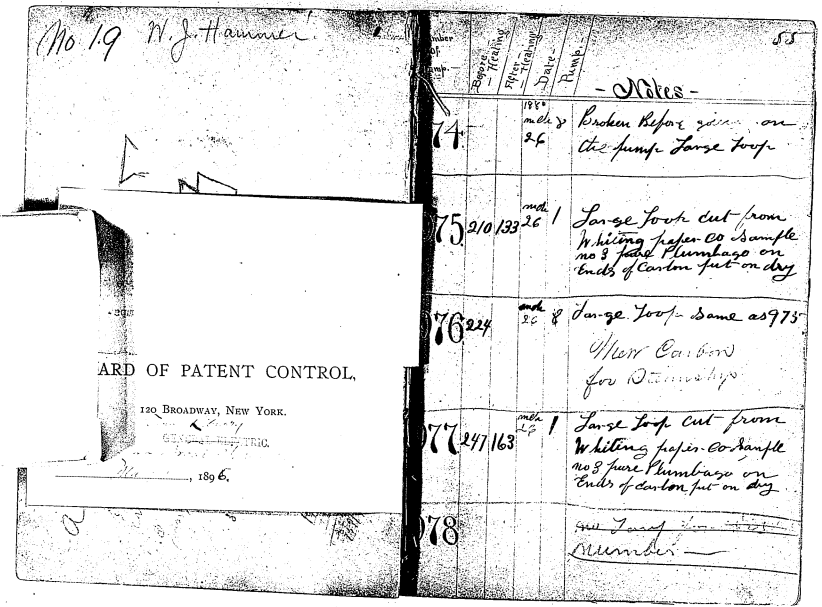
Menlo Park Notebook #19 [N-80-03-26]

This notebook covers the period March-July 1880. Most of the entries are by William J. Hammer. Some are by Charles Batchelor. Some entries may also be by Francis Jehl and Charles Flammer, whose names appear as witnesses. Most of the material relates to tests on experimental lamps, numbers 974 to 1323. There is also a drawing on the inside back cover of a Japanese bamboo filament lamp. Related material can be found in Menlo Park Notebook #41. The label on the front cover is marked "From No 974- Electric Lights." The book contains 276 numbered pages.

Blank pages not filmed: 150-159, 162-171, 174-209, 212-249, 252-256, 273-275.

Missing page numbers: 1-54, 257-272.


No 19 N. J. Hammer
March 11 1889
June 3, 1890
Notes
Edison Laboratory Note Book No. 10.
Pages 55 to 101.
Shows records of Tests on various
Number


No 19 W. J. Hammer

55

Paper Heading	Fifty Heading	Date	Page	- Notes -
		188 mch 24	y	Broken Repeat given on the jump Large loop
975	2/0/133	mch 26	1	Large Loop cut from Whiting paper Co sample no 3 pure Plumbago on ends of Carbon put on dry
976	224	mch 26	8	Large Loop - Same as 975 New Carbon for Remainder
977	247/163	mch 27	1	Large Loop cut from Whiting paper Co sample no 3 pure Plumbago on ends of carbon put on dry
978				New Loop Remainder

ARD OF PATENT CONTROL,

120 BROADWAY, NEW YORK.

TRIC.

, 189 6.

Mud—

1274
1275
1276
1277

Number of Vamp.	Before Heating	After Heating	Date. 1911	Notes.
979.	253		mch 26	8. Large Loop. Same as 976
				New Carbon for Steamship
980.	2300		mch 26	4 manilla fibers Broke at the first heating
981.	257		mch 27	Large Loop. same as 979
982.	214		mch 27	Large Loop. the same
983.	244		mch 27	Large Loop. the Same

Number of Jump	Before Heating	After Heating	Date of Test	Remarks
984	274	27		Largest Jump that Same 23 9/32 Manilla Fibre 2 in Long .005 Thick Card-Clamp small size
985.		22		Manilla fibre 2 1/2 in long Carbon broken by taking off press.
986.	416	22	6	Manilla fibre 2 1/2 in Long Broken by Last Jump while Heating
987.				Manilla Fibre
988.				Manilla Fibre

60

61

Number of Lamp.	Before Heating	After Heating	Date	Pump	Notes
989.					Manilla Fibre
990.					Manilla Fibre with Cork Clamps
991.					Manilla fibre with cork clamps on 2nd
992.					Manilla fibre Heavily charged with 206
993.					Manilla fibre Heavily charged with 206

Number of Lamp	Bygone Reading	Present Reading	Date	Remp.	Notes
994.					Manilla Fibre Oak Clamps oak connection rod clamps sealed off the pumps.
995.					Manilla Fibre Oak Clamps with ring wedge clamps
996.					Manilla Fibre - Oak Clamps - Plat Clamps Cont. 204
997.					Manilla Fibre Holly Clamps New Chadwell Brace reg Clamps.
998.			8	4	Manilla fibre oak clamps

64

65

Number of Lamps	Before Hearing	After Hearing	Date	Purch.	Notes
999.		5			Manilla fiber oak clamps
1000.					[illegible] long cylinder
1001.					Manilla Fiber Oak Clamps reg. platina clamp put in long tube
1002.		10	/		Manilla fiber oak clamps long globes
1003.		10	/		Manilla fiber wood clamps long globes

Number of Damps.	Before Healing	After Healing	Date	Pump	Notes
1004.					Broke at clamps Inboard Clamps.
1005.					Repaired clamps. Two Fibers - 1 fiber broke just previous to healing other still good
1006.					Meridian Fiber at canon broke at clamps Measured Very fine eight - Inches Electric High Vacuum
1007.		14 AW			High Vacuum all correct - 1 two fiber
1008.					1 Loop made of grain wood part - the Redstone Clamps Cent 233

Number of Lamps	Before Hearing	After Hearing	Date	A.M. or P.M.	Notes
1009.					1 Lamp marked Queen Mark but is old style clamps Cash 2.33
1010.					White Holly 2 lamps put in old style Clamps Cash 2.25
1011.					En Dr Moses pump broken while heating
1012			14	2	Wood steamed Jones Mode before [illegible] Night Vacuum
1013.			14	2	First wood Vacuum in fire Lamps burned Hearing 2 h on pumps Vacuum did not hold

Number of Lamps	Before Heating	After Heating	Date	Remp	Notes
1014.					~~Pine Knots~~ 2 Loops Gum wood cut by Dean
1015.					~~2 Loops~~ Gum wood cut by Dean 2 sheets of manila paper between each Loop Number each when cut.
1016.					Pine Cedar Cord same as 1014 & 1015
1017.					Same as 1016
1018.					Peach wood same cord as 1014 ~~1015~~ Broke glass heating on mump by ft.

72

73

Number of Lamps.	Before Reading	After Reading	Date	Pump	Notes
1019.					Amaranth Wood same cuts, as 1014 & 1015
1020.					Same as 1019
1021.					Maple Wood same cuts, 1014 & 1015
1022.					Same as 1021
1023.					Black Walnut Same as 1014 & 1015

Number of Damps	Before Hearings	After Hearings	Date	Damps	Notes
1024.					White Woolly 1st stage Damp Broke while Printing
1025.					Same as 1024
1026.					New Paper New Horseshoe mould.
1027.					New Horseshoe mould Paper —
1028.					New Paper New Horseshoe mould —

1029 New Paper
New Horseshoe
Mantle

1030 Same as 1029

1031 New Paper.
New Horseshoe
Mantel

1032 Same

1033 Broken on pump while
heating Same

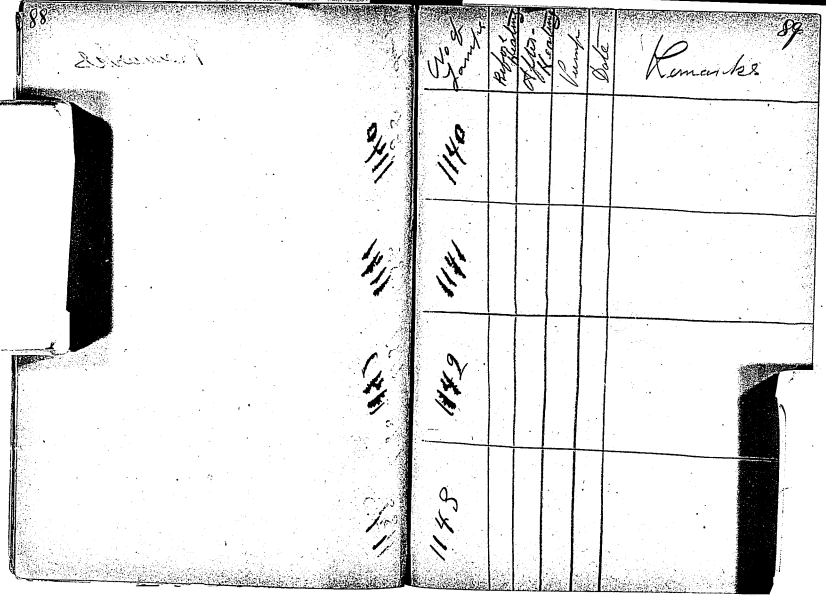
78

~~1112 Institute Road~~

Several hundred
dumps were posted
subsequently (Standard Notice) by
not received except
Special ones
by Forman
with Sealed
Warrants

		Remarks
1185	1240	Cro of Lamps
1186	1241	
1187	1242	
1188	1243	
1189	1244	

Diagram


No. of Sample
Analysis Asked
Analysis Received
Sent
Date
Remarks
1140
1141
1142
1143

No of Samples	Reported	Date Received	Examined	Result	Remarks
1144					Bass
1145					Bass
1146					Bass
1147					Bass fishes - Broke carbon after 2 hours BG TAF

92

Work No		Date	Remarks 93
1148		June 18	Bass fibes- Brake on the pump- H.V
1149		18	Same. Brake on the pump H.V
1150		18	Same Brake on the pump H.V
1151		18	Large Bass Fibes- are formed in the clamp
1152		18	Same as 1151

No. Slide			Date	Remarks 95
1115-5				Bass Fibers - Large Large With Glass Between the Carbon
1115-4			June 18	Bass fibers - Small
1115-3			June 18	Large Bass Fibers - With glass Between the Carbons Bad Spots on the Carbon
1115-6			19	Bass Fibers - Regular.
1115-7			19	Bass fibs - Regulars.

No Yards			Lots	Remarks
1158			99	Regular High Bass fibers.
1159			19	Regular High Bass Fibers-
1160			21	Small Bass fibers- Broke on the first Heating
1161				
1162			21	Bass fibers Regular- Broke at the first Heating

No Lamps			Date	Remarks
1163			21	Bass fibers - Regulas. Crack in the carbon close to the Clamps Sealed at the Clamps
1164			21	Bass fibers - Regulas.
1165			June 21	Bass fibers - Regulas - Broke at the fibers - heating
1166			23	Bass fibers - Regulas -
1167			23	Bass fibers - Regular

No of Jaws			Class	Remarks
1168			23	Bass fibes- Regular
1169			24	Bass fibes- Regulars- are formed at the Clamps
1170			12	Bass fibes- small Jaws Clamps
1171			22	Bass fibes- small short Clamps
1172			22	Bass fibes small short Clamps

Old Limit			Date	Remarks
1178			23	Bass fibes- Regulas- light
1174			23	Bass fibes- Regulas-
1175			23	Bass fibes- Regulas Shut- in the Carbons Close to the Clamps NG
1176			23	Bass fibes- Regulas are at the clamps and Close the Carbons NG
1177			23	Bass fibes- Small- Lamps

No of Lamp			date	Remarks
1178			23	Bars fibres small carbon in Long Lamp
1179			23	Bars fibres small carbon in Long Lamp
1180			24	Bars fibres Regulas-
1181			24	Bars fibres Regulas-
1182			23	Bars fibres small

No. of Form	Kind of Work	Date	Remarks
1183		28	Bars files - small
1184			~~Bars files~~
1185		24	Bars files - Regulars
1186		24	Bars files - Regulars
1187		24	Bars files - Regulars - Covered with plumbago

1188 June 24 Bass fibes. Regulas-

No.				date	Remarks
1189				24	Bass fibes. Regulas-
1190				24	Bass fibes. Regulas-
1191				24	Bass fibes. Regulas-
1192					Regulas. Bast fibes-
1193					

No Yards			Date	Remarks
1194			Same 26	Bass fibes - small G. Hill
1195			26 Same	Bass fibes small
				same
1196			Same 26	Bass fibes small
				same
1197			26 Same	Bass fibes small
				same
1198				

112

1274

Three Years of Grace

Lands to Abut Church Court

Rest Common in Other Words

Hamm

W. Hammond

Lamps Exhausted of Oil

1269 Corn June 14 15 16

Barn fitten disposed in Shutters

Colyton of Common

No effects same order

as all the amounts

June 15

1270 Barn fitten Shutters

same as 1269 in effects height

same order as all amounts

June 15

1267 Bristles goon as to

comment on did not-get

part of the custom mount

mute June founder

June 15

1268 No effects 100 Mr. Ne.

slightly slow in the high

Start-June 1950

1271 Hyd Z ~~Fav norm 200~~ 100 mm m
Spots

June 16 1880

1273 Barnsley Pikes ~~as~~ chalk
Hyd rec Cairnmuir 100 m m
Fothe circ slight cream

1272 Barnsley ~~Pikes~~ [illegible]
Obs Pit rotation [illegible]
deco. [illegible]
Thin [illegible]

1274 Good [illegible]
slightly [illegible]

1275 Good [illegible]
slightly [illegible]

1276 Barnsley with notch
in it one very bad spot-in

11

11 Part not cut the rest 119

July 17 1880 am

Bamboo With notch cut in one side
1277 High Vacuum 98 [illegible] very good except
water near burgess [illegible] 98 [illegible]

1279 Gave a good Light
no spots from 10.15 to 11.50 am
high Vacuum sealed off

1280 Paper Carbon Had lots
and new Parchment Carbon
Sealed [illegible] a high Vacuum
1.10, 2.45 Pm

1282 [redacted]

Shipley and Andrews York

July 19, 1880

1283 Bamboo fiber.
Broke the carbon as soon as current was put on close to the clamps did not give any light

1285 Bamboo fibers-
no spots it gave a good light Vacuum When sealed off Vacuum 108 one hundred & eight

1286 Bamboo fiber-

gave a good light it had no dead spots in it Vacuum 102

1287 Bamboo Fiber-
no spots it gave a good light Vacuum 107

same as 1286

July 19, 1880

1288 after 2 hrs. High Vacuum
Bass fibre - after 2 hrs. Syrup.
Vacuum 100.

1289 Same as 1288
Gave a good light no specks
Vacuum When sealed off 103

July 20, 1880

1290 Bamboo fibre -
It was very bright - and
one side of the carbon and
had specks in Vacuum When
sealed off 100

1299 Bamboo fibers-
very fine no [illegible] gave
a good light- Pure Iron
Incandescent Filament Vacuum 104

1291 Bass fibers- With Platinum ends of Carbon no Specks
[illegible] gave a good light
Vacuum [illegible] 112

1292 Bass fibers-
Several Bad Specks in Carbon
Bright Spot in the Centre of the
Carbon and it did not give
very good light Vacuum 104

July 20 1880

1294 Bamboo fibers- no spots in carbon it was very even and gave a good light- after it Burnt for about half an hour- found out that the carbon was split in the Clamp-

July 21 1880

1295 Bamboo fibers- there was some bad spots in Carbon as marked here

Vacuum when sealed of 105-

1296 Bamboo fibers- it gave a good light-

Vacuum when sealed of 109

Tuesday July 21. 1880

1298 Bamboo fibers.
Other Was carred [illegible]
One Carbon Vacuum When sealed
off 10½

1800 Bamboo Fibers.
one side of the Carbon Was
dark and the other - Light-Red
Vacuum When sealed off 10½-

~~10 Red Beauties~~

C N G

1311 Real Bamboo fiber - very even no split in Carbon after it Burnt [illegible] one four-fourth [illegible] other Carbon Was Split in the Clamp

Vacuum 112

1312 Real [illegible] one side of the [illegible] is a little [illegible] the other - after it Burnt four O. and are [illegible] and that the Carbon Was Split in the Clamp

Vacuum 112

1301 Bamboo 12X12 Regular
oxygen no spots in the Carbon
after it Burned for about one
hour found out the Carbon
was split in the Clamp
Vacuum 112

1302 Bamboo 12X12 Regular
sealed up there was a Crack
in one in side glass could
not get a Vacuum

1310 Japanese Bamboo fibre
Bad spots in Carbon as
marked there was a
split in Carbon in the Clamp
it did not show the split visible
it Burnt for about 2½ minutes
high current - Vacuum 112

134

March 26 1884

July 22/1880 135

Japanese Bamboo 1314
Broke the carbon as soon
the current was put on
did not give any light High
Vacuum

1313 Japanese Bamboo Flat
Broke as soon as current
was put on did not
give any light

1305 Bamboo Regulas.
w/ 3 small splits in the
B. Rome of paper and gave
a bright light on the bottom
of carbon Vacuum 112

July 22 1880

1304 Bamboo fibers

Several Bad shots in the Carbon But it gave a Bright Blue Light Blue Vacuum 114

July 23. 1880

1316 amaranth Wood

the carbon [illegible] which gave a Bluish Blue very Plain Vacuum 104

1307 Bamboo Fiber 12 X 12

[illegible] no Splits after it burned for about 2 minutes from the Carbon Split in the Clamp it gave a Bright Light Vacuum 114

Chas F. Hammer.

July 23.1880

1308 Bamboo fibes. 12X12
no spots it gave a good light
Slightley Blue Vacuum 112

1309 Bamboo Fibes-1
no spots gave a good
light-
Slightly Blue

Vacuum 110

1310

See page 133

July 23 1880

1311

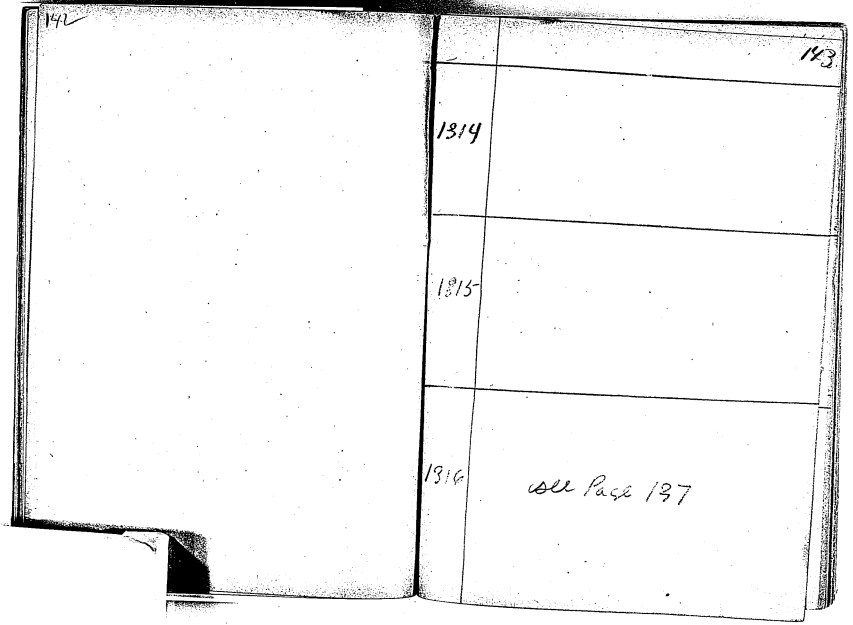
See Page 131

1312

See Page 131

1313

See Page 135


142

143

1914

1915

1916

see Page 137

144

July 29 1917	ordinary Bamboo no spots gave a good light has a slightly Blue VACUUM 112
July 24 1918	amaranth 12X12 Bad spots in the Carbon showed the Blue very Plain at the Clamps Sealed of Both Legs Vacuum
July 24 1919	White Hollis Bad spots in the Carbon and gave a Poor Light Vacuum 103

Mercury B

July 24 1890

July 24 1890
White Holly
Bad Spots in Carbon
& Showed Blue
Plains from the Clamps
and Carbons Vacuum

July 24 1891
TULIP. WOOD. 12X12
Broke on the Clamp
by the mercury
Running in the Lamp
Vacuum

July 24 1892
Bamboo Fiber
no spots it gave a good
light it was
Slightly Blue
Vacuum Blown Accidently

148

149

July 24 1923 Brass fibes - one [illegible] Clamp but it Gave a Bright light

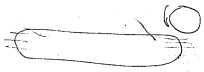
1924

1925

July 23. 1880.

1241 Bars Fibers.
Bad Spots [illegible]
and did [illegible]
[illegible] Vacuum 110

July 24 1880
1239 Bars fibers- Extra
no spots let pass
a good light
Vacuum When sealed 110



John D. Daley
Kilkenny

276

72
187
116
152

477
44

521
296

817

Japanese Bamboo Pillow

K

Bamboo pillow.
Part of
[illegible] Tamil
Column of the
Pillow of Rama

Column Headpiece

1

1/8
1/2
1/6

Menlo Park Notebook #20 [N-79-02-24.1]

This notebook covers the period February-June 1879. The entries are by Edison, Charles Batchelor, and Francis Upton. All of the material relates to experiments on electric lighting and on the telephone. The electric light material includes notes and drawings of lamps, coating filaments, and generators, among which is a caveat drawing by Edison. There are also notes and calculations about electric power distribution systems and notes on experiments to be performed. The telephone material relates to a series of experiments by Edison and Batchelor, many of which were on chalks. The label on the back cover is marked "Caveat," "Thompson," and "Jose Husbands." The book contains 284 numbered pages.

Blank pages not filmed: 54-55, 266-269.

Missing page numbers: 271-272.

No 20.

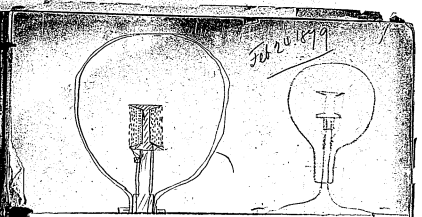
1/2 inch 9/100 .00

20
.060 1/32
.030

1/32 .024
2
.1048
.1024

6 inches .010
.030
6
6 inches .010 is 2/ .180
.08 .09

.18
64 X 8 12) .18 (01 5
12
60
19.2 48
3.8
1.9



Feb 2 1879

Edison Laboratory Note Book. No. 20.

Pages 1 to 15.

Incandescent Electric Light.

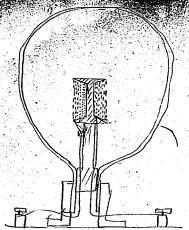
See Edison Patents:
214,636
214,637

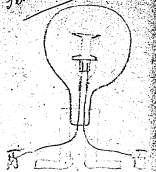
No 20.

1/2 inch 3/100 .00

20
.060 1/32
.038

Feb 2 1879





Iron Platinum

Nickel Platinum.

Iron – Platinum foil.

Carbon in coiled state coated with lime and sealed in platinum – or Pt-Ir. – or Iridium cylinder

[illegible] OF TARIFF CONTROL

120 BROADWAY, NEW YORK.

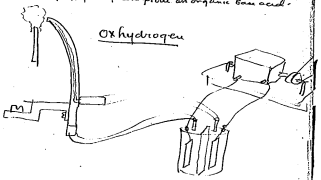
GENERAL ELECTRIC.

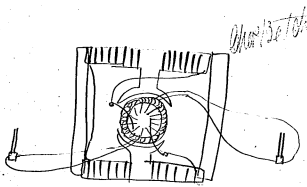
[illegible], 189[illegible].

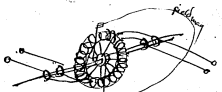
Feby 24. 1849 —

puffy magnesia from an organic bone acid.

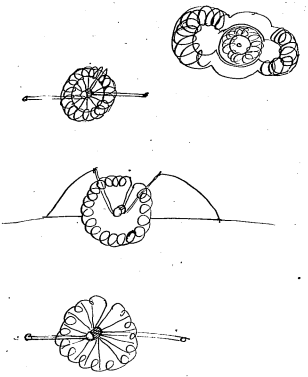
Ox hydrogen







Feby 24. 1879

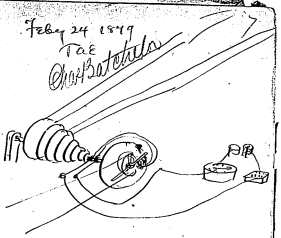


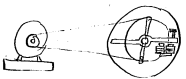
Chas Satchell

Feby 24 1879

TAE

Chas Batchelder

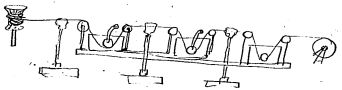




Dynamometer

Feby 24 1879

Chas Batchelor

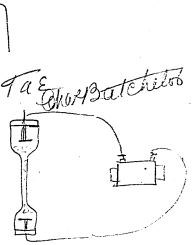


Coat wire by a saturated solution of a salt of Zircon Cerium - Magnesia, Titanium, Lime, Alumina, or other infusible oxide -

Several coatings can be put on -

Instead of heating by the direct flame a thin tube may be heated & the wire pass through that or through a Coil of platinum wire kept

Incandescent by a Battery -



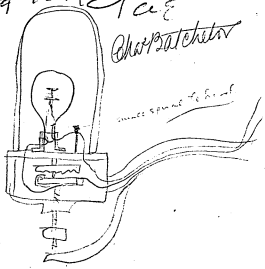
Feby 29. 1879 Tae Edison Battery

full puffy ebria
Lime or magnesia
Jump Spark -

H

Feby 29 1879 T.A.E

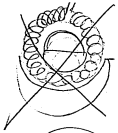
Chronotachister

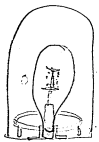


Lamp connected to Coil for quantity Lamps

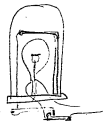
Feby 29, 1879

Ta E
Edw Patentee





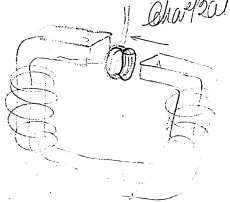
Platinized
Zinc rod

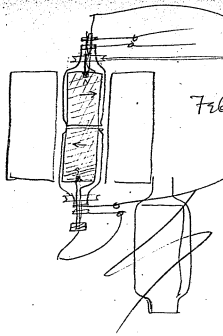


16

15

Feby 28 1879





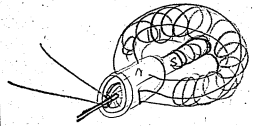
Feby 28 1879

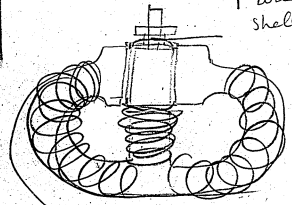
Gas

Chas. Batchelor

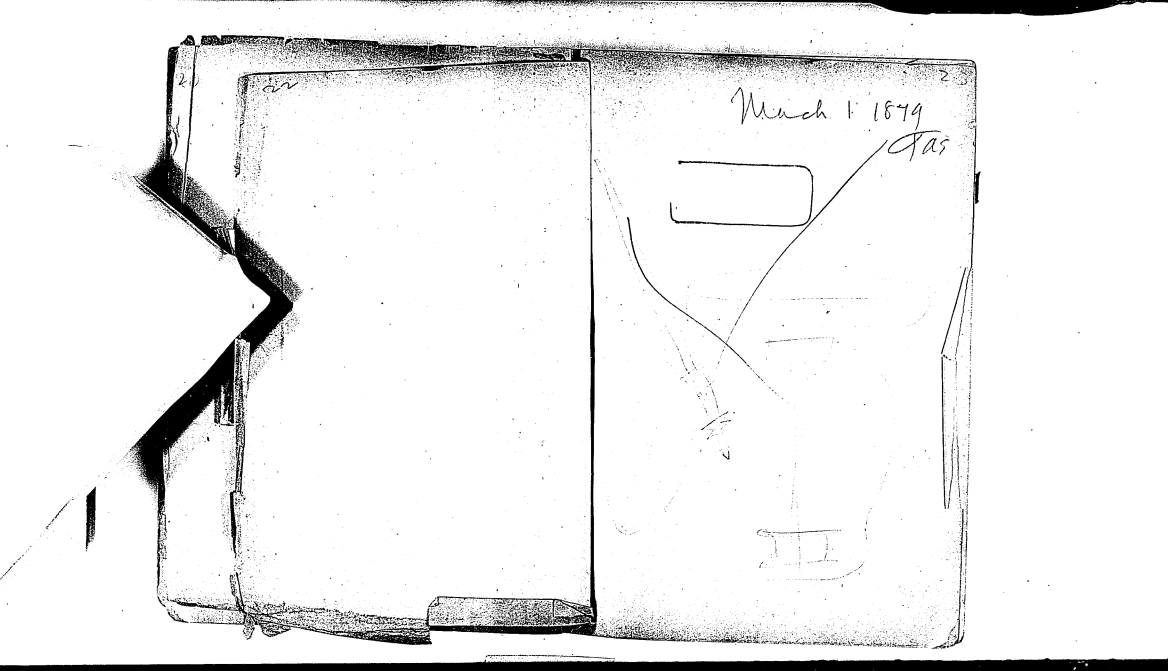
March 1 1879

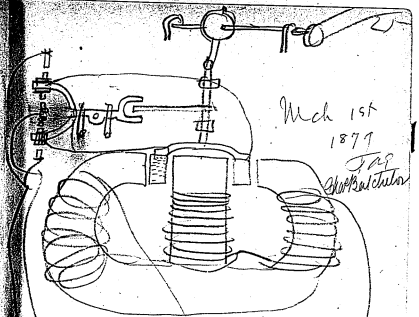
The
Shrapnel shell



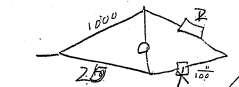


1 mm
Shell

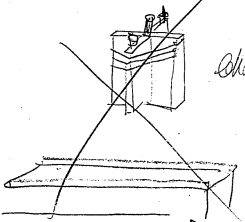

March 1 1849
Jas

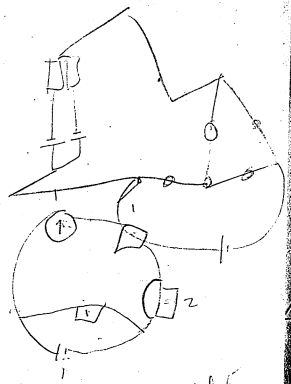

Mch 1st
1879
also with Commutator on
Revolving Shaft

.01
.02
.02
.05
.10
.2
.2
.5
1.
2.
2,
5
10
20
20
50



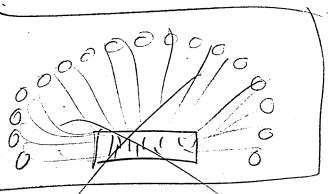
March 1
1879
Jas
Chas Bostwick





4 + B. 1. 1. d. 5.

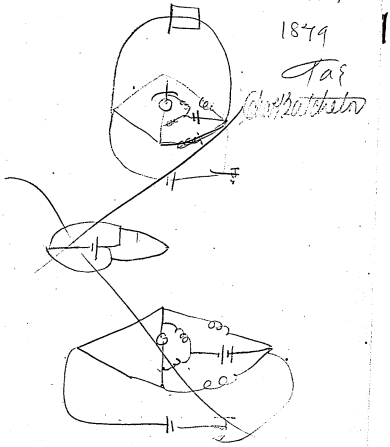
Y/5 N/3 3/11 Y/5



Mech 1st
1877 Tat
Chas Bolthelon

March 1
1879

Gas
Carburetor



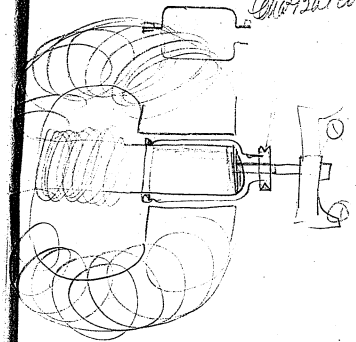
32

33

Coil of
Square Electric
Machine

March 5/79

T.A.E.
Chas. Batchelder



35
35
4 times 7 stays each
if white wire
March 5th 1879
AF

Wire No 16

Resistance 1·37 ohms

Resistance for 1000 feet 2·45 ohms

∴ 2·45 : 1000 :: 1·37 :

137	
245) 137 000	559
1225	
1450	
1225	
2250	
2205	

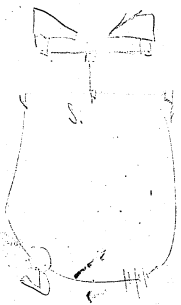
559 feet in all together

138 turns
13

Gram Ency 147

March 5th 1879

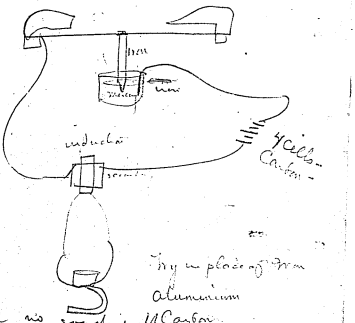
Jas



Telephone Experiments

May 20th 1879 -

Chas Batchelor



Try in place of Iron

Aluminium

All no good with Carbon

the exception of

carbon which was

very low + indistinct

Sulphide of Boron

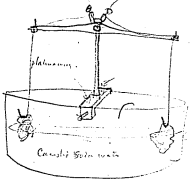
Sulphide of

Chromium

Platinum

Experiment no 2 67

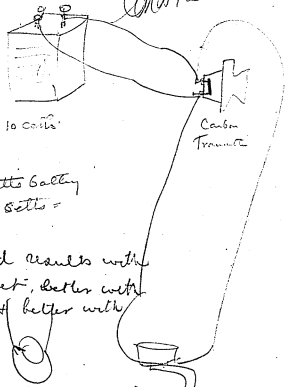
Malograph Engine (15) Cap. Chloroform



Dr. Ralph Batchelor
May 20th 1879

Experiment No 3 - 43

Short Batteries

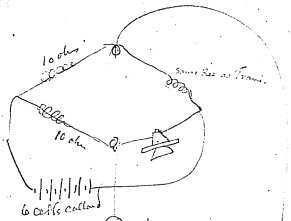


Exp. 2. Same Battery
also 3 Cells =

good results with
one Cell, better with
two & better with
Three

Talked through 126.4oz Ohms Resistance
heard it but very feeble ly. BSC

Experiment No. 4. VJ



6 cells each Limit Ohms Total =

worked pretty good.

Clear patches

Chalks March 28th 1912 47

Short Batchelor

1 }
2 } mounted pretty dry good
3 } talcking not very
4 }
5 }
6 } loud

1 2 3 4 5/8 soaked in water
for 2 minutes
6 soaked 5½ mins

stood 26 mins
all talcked loud but 6
not quite as loud as others

stood 6 hours
5pm. all talcked equal now
very good

All put on for 3 minutes more
except 6 and left it in 5
minutes

1 2 3 4 5 have been wet now
5 minutes
and 6 10½ min altogether
Stood 20 minutes
they do not seem to dry
quick especially 6 which seems
to have a great deal of Cavatte Eda on surface

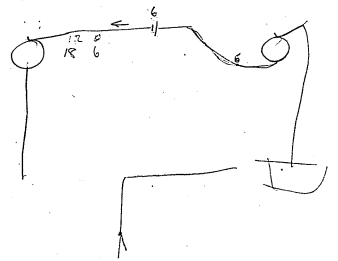
after standing 20 min I tried them and
found they all talked a little low but
6 was the best so

I let them stand 15 min longer

they now come up bowl all alike

I now put 2 4 & 5 in crock and

and put 1 3 & 6 in water for 5 minutes
making 1 & 3 — 10 minutes
6 — 15½ minutes
Let stand 1:30 minutes & Edison tries them at 7 pm May 28.
They now stand as follows
1 wet 10 minutes
2 — 5 ——
3 — 10 ——
4 — 15½ ——
No 2 is loudest
No 4 is next
No 3 is next
No 1 is lowest & seems wettest
Left out at 7 pm May 28-
Tried them at 10 pm (the same)
Left them out


6
12
R
6
6

56

Oregon Oregon

Portland Oregon

Oregon

Berlin Oregon

Washington Territory

Portland

Ohio

Berwinville Ohio

57

June 18. 1879 T A E

Charpatchets

Record of well ground Checks etc for Chemical Telephone

Unknown — Nil-

Regular - Hg acetate added daily + well worked after ammonia NaO, added + organic well worked after

This check received not in use until Wetted - 7 shunted galvanometer Galvanometer with a Brad ley coil. With no shunt it was low but - putting in shunt of 35 ohm made it quite loud + shunt of 5 ohm the maximum loudness. 1st class but not extra loud. 2 ohm = Patched together

Not adjustable

R. 3200 @ 2500 one mouth
6000 @ 3700 other side.

Pt-3 to Cu
Cu 300 to Zinc
Rubbing small def to Zinc

54

402

30 grams sulphide Hg. (Merck)
NaO, Chalk. wet. grind, clean
pretty loud with only 5 ohms in
shunt quite low with 20 ohms
& hardly hear it without shunting
polarizing battery, & heat to wet
it- dry get nothing. Lacking
clear cut. Colored in shunt
Color white to flesh color.

R. 45000 grms Hg 2000
Pr- 10 to 2mm Ent Rubbing Dry Mixing
Con 150 "

59

403 Mushy Black oxide Hg. NaO, Chalk.
had to wet = good but not very loud without
shunt slightly more with shunt
35 ohms. any less God = & wet at
the mush and it cuts Pieces of chagle
stick to spring & steel & covers it
so can scarcely hear it was
quite loud on 35 ohm shunt
Dont polish- Cut groove 1/64
deep & too much in color.

R. 90000. due to 1000, Patte slowly when polarize.
Pr. 20@30 Tenuate 2mi
Con 150. "

Rubbing- Medium Deflection

6c

A.04

6

R-grass grants 27/00. Ben palmyi
Rs 3 (round) 2 wi Rubbing very much depleted
Rm 20 "

Chalk

+ Concentric

ground not

Regular NAO. -

scattering

XX bad - Can scarcely

to straighten

at it Cells

Cohen in short

Palisaded Tissue.

1.0.6. Regular

ground

ground =

Corner fair - Waste

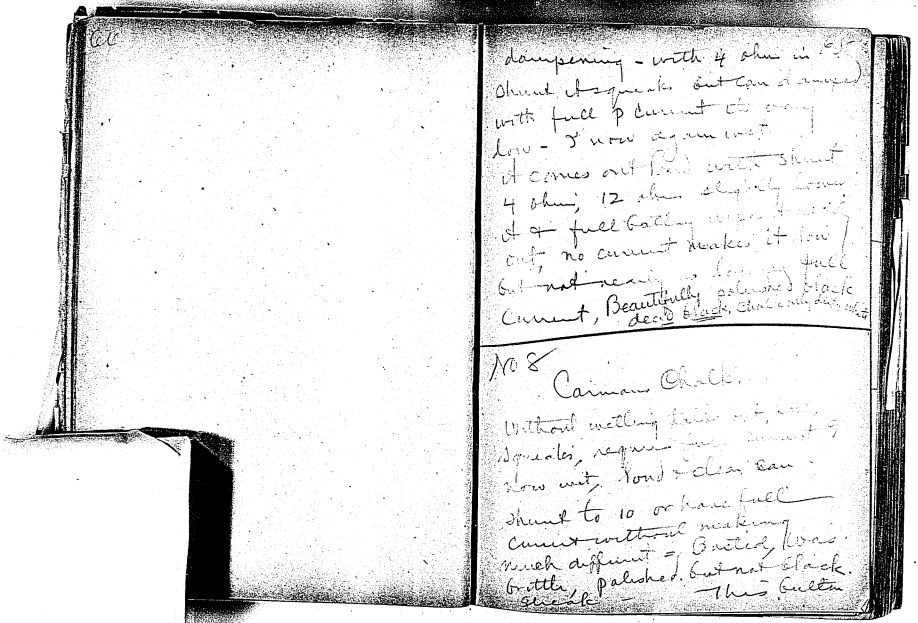
to palisade = Thick

after wetting, it [illegible] very loud - [illegible]

A.M. 1. Check, [illegible] No. 0. ground [illegible] Ro [illegible] [illegible] go until [illegible] - answers very Loud - clear - hear [illegible] without [illegible] 4 ohms - very [illegible] full battery - [illegible] [illegible] slight battery - probably [illegible] was more Hq [illegible] a Summit - [illegible]

[illegible] PM again [illegible] it works but not so loud, have to use about 4 ohms, [illegible] Summit [illegible] fearfully [illegible]

MAIL



dampening - with 4 ohm in
shunt squeals but can be damped
with full p current etc very
low - I now again use
it comes out best with shunt
4 ohm; 12 ohm slightly worse
& full battery with 4 ohm
out, no current makes it too
but not near so full
current, Beautifully polished black
dead black, clear only dull

No 8
Cairnaan Black.

Without melting battery out with
squeals, requires
low unit, loud & clear can
shunt to 10 or have full
current without making
much different = Battery lasts
better polished but not black.
Thus Gelton

Citronella conversation with a dutch angel with tight boots

871.

842

29 lbs def

8469600209 64

86 8 135

8960009609 7610

8.17

was made of 7½ grains metallic Mercury 3 oz Chalk, ½ of NaO.-

No 9

Hard Sodium Amalgam, made, Chalk + Rec NaO - ground well.- Watched it without watching = after watching had to shunt + got it laid. Shunt 10 ohms but it was fair on full current after which as NO gradually went on Chalk putting on shunt on full Current made no difference: after watching again, for first instant shunt lost in 1 minute made no difference With full Current in shunt = Loud clear - returned Ge

polished black but for the coal &
marks, the show that it would
take a large further amount
of NO, as it returned to hardness
after wetting twice.

No 10, (Bradley mixed)

2 oz Chalk
3/4 oz Comitat Ra.
9 grs Calomel.

Talked low without wetting;
after wetting loud in 10 secs
Amount, after few seconds scarcely
any difference between full Current
& Shunt, but in 1½ minutes
full Current made it much lower
than Shunt. - 9 wet again
without Current No 9. - 9 wet again
It gets a little louder but same
phenomenon occurs - this is very
loud & clear. — little pulled
no flocks

Extra Experiment

Reg Bannin. Having Lost the Hg - had another Lot Hg mixed & rammed in had to wet - after wetting - not loud, full & shunt fast to wire.

R: 1000 - no decrease polarizes immediately
Pt 28 towards Copp
Cu 200 @ 25°0 - Rolling small deflection on
a port of the deflection opposite direction.

No 11, Mercurous Nitrate, + Reg Chalk + NaCl -
Must wet - after wetting it came very loud, & it made no practical diffrence whether Current on or not. — Phenomena

on wetting 2nd time very loud, & it wets shunt is down once got hardly anything which only just Current Loud & it wore. Once Current Loud & it wore. fr polished block Sat. tool blanks prevents — another Phenomena:- & wet it

again ~~it~~ it comes loud, 73
& is about same with shunt
of 10 ohms on or off – but in 2
minutes its same as 1st
phenomena, shunt is low &
full Current is loud.

No 12.

Chalk NaO – precip block ox
Hg just after precipitation =
Squeaks at regular pressure
with full current – Talking with at
wetting low = Snow wet =
This has a spot in it that works
loud & the rest low. The loudness
is not very great, Must use
full Current, ~~No~~
Hardly hear it on shunt of
10 ohms, soft = no polish – groove sunk

13 —

Sulphate Hg - Chalk + NaCl
dry low

Phenomena — melting Hg very low no difference in shunt or full Current - Can barely hear anything at all, More melting Nothing but exceedingly low

Cuts = dont polish = sunk in.

14 Mercurous oxide - Chalk + NaCl
wet it, opens louder but not XX loud. its little louder with 10 ohm shunt on - but speaks nearly as loud with full Current without a quiver - Keeps same for 2 minutes - Dried again, same = daft.
sunk in dont polish

R 9700 @ 1/100
short full 1/10 2nd 1/2 2nd

Terms Very low - Low. pretty loud X loud XX loud & XXX loud -

R 3500 Ω 2200

Ph – 5
Cu 200 — Normal Zinc
Rubbing along deflector

15 =

Block OX, Hg Mush. Chalk
NaO =
Hg until wet, then X load
with shunt & ohms. 1/2 or 1 load
full Current, but with shunt
squeaks slightly, then hold after
10 minutes – Polished but pitting –

16 – 50 grains Acetate Lead,
in NO, NaO + Hg Chalk enough
ground – after wetting, low
but shunt on or off absolutely
no difference in Loudness –
but squeaks slightly with
shunt on but only 2 ohms very poor
after 2 minutes squeaks
bad with shunt or full
current but makes no difference
– Looking – polish but
Chalk mixture –

17 Chloride Ammonium
Bichloride Mercury
Chuck – well ground

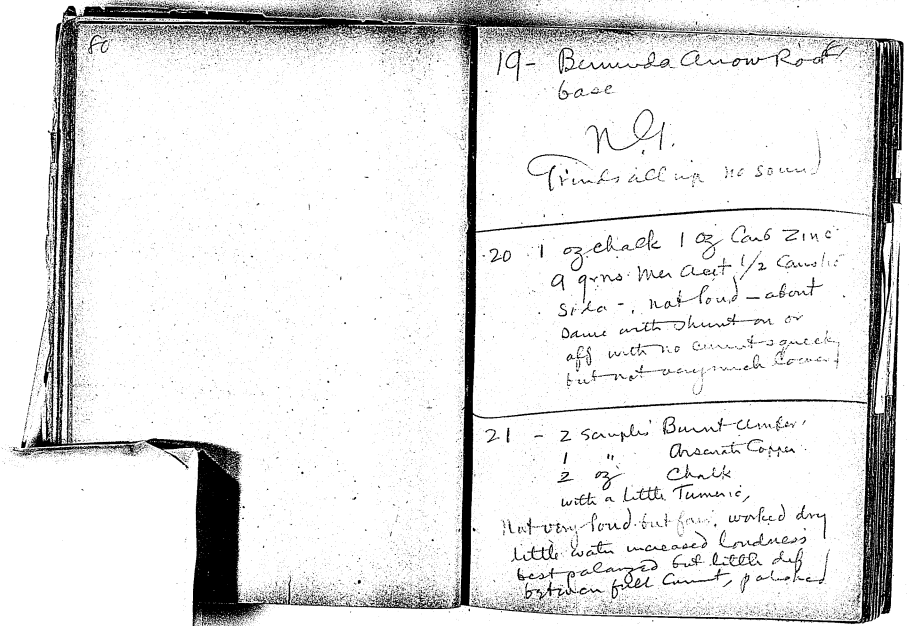
Pretty fair – low – best with
3 ohm shunt twice as low with
full Current, wet it twice
didn't do any better 2nd wetting
Faith) quite low before wetting
getting louder after 2 minutes.
no magn. in galvanom. 2 ohm shunt dif

Phenomenon – Sprucks with
Feeble Current, Strong Current

Wetting 3 times produced no change
during 1 hr. Sprucks with Strong
Current in 30 seconds & faintly

18 6 oz Zinc Carbonate
9 grains Acetate dilg
½ oz Caustic Soda.

Low – on either shunt or full
squeeky –


19- Bermuda Arrow Root
base
N.1.
Trinds all up No sound
20 1 oz chalk 1 oz Carb Zinc
9 grns Mer Acet 1/2 Cans Sulp
Silica -, not loud - about
same with Chlorate or
Alf with no current squeaky
but not very much Current
21 - 2 samples Burnt Umber,
1 " Arsenite Copper
2 oz Chalk
with a little Turmeric,
Not very loud but fair, worked dry
little water increased loudness
best balanced but little dull
by brown filled Current, pulsated

82

8600000 8.1

560 56 15 20

96- 5 5 0 0.

56 86009609 90.

England

81 98

England 960

56 5609609

Percentage. Mirror 94.7 - 82 pc...

Elect. Dynamics - 86 - 7½ p.c.

EMF 135 Volts

22. 18 grns acetate (end)
Chalk + NaO,

Mg. Low, works some [illegible]
off - friction bad [illegible]

23- 6 oz Barytа
16 - pennyweight 12 grs. Sodium [illegible]
1/2 oz NaO.
Had to wait it - then it was
Daft - Low, - cut chalk -
groove 1/32 deep. - no diff.
on shunt or full current.

R. 35-00 @ 12.30
Pt - 140 16 a. Bad
Rolling mean Inside Coil

24 → Reg Barytа
Mg at all. wait it
slightly too.

Rowland.

84

25 6 oz Barita

8 dwt - 6 grs. Soda Amalgaman

1/2 Caustic Soda

No 1. Heavy slow - no difference

shunt on off - squeaks No

Emg action

Res. 11000. spot to 3900
Normal, 10000 to 3000
Pt 6 to 2 min 3 sec with spot
Cu 60 " " 2 " " "
Rubbing - Insert detector

26. 1 oz 13 dwt. Amalgam

6 oz Barita 1/2 oz NaO

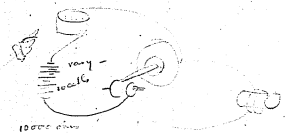
No 1.

R. 8000. goes to 1500. Item constant Pb - 6 to 2n
Rubbing during deflection Cu 150.

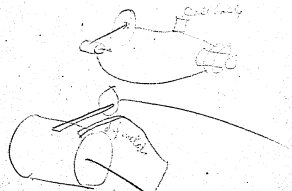
No 9. Put on again & dident work at all. Took out & cleaned everything Considerably found it changed somewhat was lower on shunt than full Current to-night also a little lower —

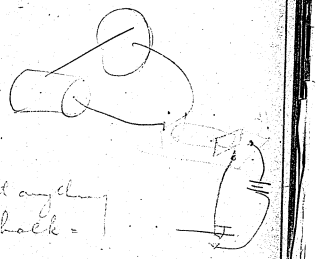
85

Experiments -



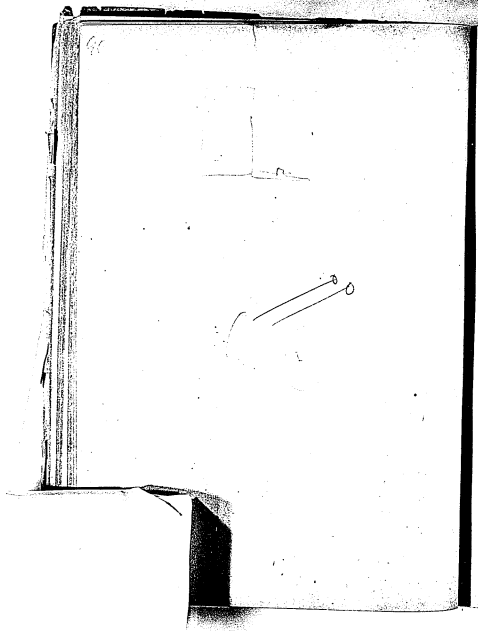
Try cell battery here





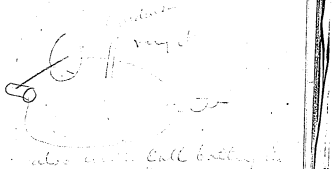
Use of gas any change in dry Chuck -

Measure the Resistance in the Chucks after testing -

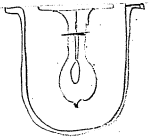


test the current with a shock
given different speeds.

Try high tension coil for use
in laboratory.



Upton has two platinum
wires in Carbolic Acid
Cincinnati — Test also in
H_2O, different [illegible] acidulated
Hg-fulminate — H_2O & Alc.



My EMG [illegible] Sedimentary and Igneous Rocks Dated + Signed — day —

with 4 checks with 1/2 of [illegible]
HCl - [illegible] with
NaOH 20 drops No [illegible]
required no [illegible]
immediate [illegible]
of adding [illegible]
checks [illegible]
in 4 minutes [illegible]
a dark [illegible]
[illegible] emulsion
ink as they come from
mixed very well but
stays. Leave as warm
slightly more [illegible] emulsion 2
Check the same as above
with the exception that 9
grms acet Hg added to melt
same [illegible] perhaps a
shade louder but requires

full battery to polarize or rather it Requires a Current but it may be weak or strong it makes hardly any diff— 2 Cells not a good —

Put on a Bunsen with HO made Alkaline with NaO, 20 drops Cannot get a sound with or without battery = Harsh - don't polish grinds the ~~Chalk~~ Battery

Put on a Chalk HO, with 20 drops & make mod strong solution Soda & put Chalk, the moment we add the soda it requires battery - to polarize when it soaks in & wants full battery

but 10 ohm will work -
The last few checks are
sensitive to replacing
outer rotor ring & end.
but found Enough to
Writing with NCl, pretty
strong makes it London than
weak 20 drops already in.
There is no streak in these
Cuttings - it was undoubtedly
the excess of Caustic that
produced that -

I try another Bangla. NOC & NO,
20 drops & rest of with weak
NOO.NO, Nothing written
written but Cutting,

Fundamental Experiments.

(No 3) - Chalk and water = as much as one man can put on pressure with 2 levers = Without wedding - polishes beautifully - pretty fair. can read with ear 3 inches away - clear don't squeak - any current weakens it - Put acid on paper - water lowers it greatly / added Sulphuric, had polarog. for ff 6 of Uptons list.

Resistance 5500 ohms

Pt. 5 towards Zn end

Cu 60 " "

Rubbing sharp towards Zinc end

Same difficulties in all parts of circle. polished very much did.

But after wetting + adjusting Transmitter little it wasn't very loud.

No 2. Two of them. As much pressure as 2 men can put on with 2 levers; 1st one was without anything loud enough to hear 1 inch away increased pressure lowered it- requires no polarization current, afterwards got so loud could hear it ~~with~~ to read perfectly with ear on diaphragm — 2nd one as, louder with pressure, no scattering could hear ~~to~~ read 2 inches away it buzzed -

uptons test

R. 8000.0
Pt - 5 to Zinc end
Cu 70 " same deflection in all parts. rubbing shining to Zn end. the deflection in all cases diminishes as the point remains a long time on the chalk.

Chalk + H_2O - 105-

(No 1) - 3 hours & 2 men as much pressure as they can put on — Chalk had initial inclination - hour reading 4 inches away then gave up to broadness of chalk tendency to squeak - with less pressure not so loud - no squeak - polish after -

Original Chalk =

Hard, without weathering. Tendency to aquiclude. London ord. more thick than the other, get Emeq-jumps with polaq battery. Fault battery too strong 5 ohms in ohmmt maximum hardness, = can't read much away. q-d on with 6 ut tool mark in it.

Upton, Test.

Res 7501 ohms. seems to polarize quicker in measuring. Pt. 2 to 2mc sup. Qr 40 to 2m. no difference in deflection rubbing gave moderate deflection

Original Barrier, with ~~Exhn~~
Hg added for that driven off by
heat. Hard, rather rough, great
tendency to squeak, have to burn
& polish before talking comes so
can hear, only just heard 1/2 inch
from diaphragm too much escape
noise, squeaky even with less
pressure requires 5 ohm shunt
& current.

Upton test

Res 1 side 40 000. other side 80 000.

Pt ~~to~~ 2 to 2m End
Cu .20 to 30 — Rubbing smooth
effect same all over

Chalk. with 1 man pressing on 1 lever. = Brushed.

4 oz @ Chalk. + H_2O. 2 grains sulphate Soda, hard - Natural sky comes out so can work 2 inches away no wetting, any current works also no Emy Jump, White glassy polish

Uptons Test

decrease
R 4000 @ 2300 — dec R by C.

Pt - 3 towards Zinc

Cu 300'.

Rubbing - Strong def to Zn end

No 6. 4 oz chalk. $4H_2O$. 2 grms Cheap [illegible]
Substrate Potash - hard - no binding
to squeak - not scrapy. Can scrape
it mechi away sometimes. Mutcher
pretty clean. Was Emy slight jump
towers talking with my Comment,
Very smooth one, what you may
polish.

Uptons Tests.

R 4000. to 1600 due by C.
Quite rapid change and polarization
P+ 5 towards Zinc
Cu 300.
Rubbing - Strong Diffraction

(7

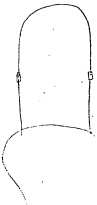
4 oz Chack H_2O, 2 grains
Chloride Ammonium, heavy precipitate
Hard. No sparkle, not loud
appears that saturation not
good, any current leaves
Cu jump very easily to get
it all or nearly all have to put
ear in deeply to get it
(and even with this) 4
inches away still don't get it
very plain. Coal makes no
impression

Upton test

4500 ohms

Pt. 6 to 2 mic cm)
Cu 70 "
no change in various parts nothing
strong change

116



75

115

Prof. of H2O.
Chalk 1 main pressure

Very smooth with hard pressure no scrape - talking Clear & makes away, any current to evens, Emy jump slight, polish - very slight cut, but had on too much steam,

Uptons test.

Res 6500
pt 5-@ 4 to zinc end
Cu 250 "
Rubbing strong, difficult in groove not so strong as outside.

4 oz Chack, $4H_2O$. 2 gms. Nitrate ammonia. Heavy precipitate, hard, not very scrappy. No spreak. Read 4 inches away any current bowing it, pretty good one, Emg Jump (10 divisions) smack, glassy polarity. To all marks, upturn test,

Res 1600 @ 1200 ohm
Res decreases after current has passed a few moments.

Pt 2 to zinc
Cu 75- " less in groove
Rubbing gave very strong deflection to Zinc end,

No. 4. 121

4 oz Chalk + $\frac{1}{2}$0. 2 grms
Substitute Soda. Light pressure
Softer - not very scratchy
Scratch - Read 2 inches away
any Current known it.
Emery jerk not shining.
polish glassy - Cuts very slightly

Upton Test -

dec.
Res 1300 @ 1100
Resis decreases with Current
polz afterward =
Pt - 5. toward Zinc
Cu 300 "
Rubbing medium deflection.

105°; Chalk 4½20. 2 grms. Cl⁻ Na,
Light pressure no squeak
very mod scrap. Read 2 inches
away. Emery rung not strong.
any current [illegible] it.
polish glassy

Upton Test.

2000 @ 1100 dec
R fell as current passed, very slowly

Pt 5- towards Zinc.
Cu 250 @ 300 "
Rubbing. medium diffusion.

1905. Heavy pressure, Chalk 1/4" H_2O, Na Cl. 2 grms, Hand, not scraping. Emg action small amp current - lowers it, read at 4 inches away, polarised strong

Upton Test

R. 3000 @ 1600 - dec by current

Pt - 5 towards Zinc.
Cu 300. "

Rubbing = strong def towards Zinc

No 7. Light pressure.

4 oz Chalk. 4 H2O. 2 grms. Chl ammonium
no scraping - not a weak hissing comes.
read about 7 inches away
Emy action small, any ammt
greatly weakens sound. polish
glossy.

Uptons Test

Broke the Putter =

Chalk. ② oxfilm.

With pressure of 1 man pressing on lever 3/4 out.

Soft. Emy action smooth, any current weakens it. Read with ear on diaphragm but not well. little scraping, not much, no squeak. Cuts a little: polish glassy

2nd Chalk Sent same, Upton Cook

Res 5000 @ 350°

Resistance decreases after the current has passed some moments.

Pt 5- to 2mc end

Cu 300@350 "

Rubbing strings very slight deflection.

4 oz chalk H_2O. 2 grains Chloride Calcium — Heavy precipitate. No Scraping at all, no squeaking. Read 10 inches away. Emy action small, any Current weakens it. polish g Cassy — Total marks slightly.

Upton Test

2000, @1700.

Resistance decreases after the Current has passed through for a few moments, then seemingly increases + polarization occurs.

Pt 15 @ 20 towards zinc end
Cu 240 @ 300 " "
Rubbing Strong deflection.

132

9

133

Light pressure, Chalk H_2O, 2 grms
Chl Calcium: about same as heavy
pressure but not so loud Read
4 inches away Emy acts
not strong, any current
weakens, glassy polish - local
marks slightly -

Uptons Test

R fall from 4000 ohms at first
Tap to 1500, before pulsing

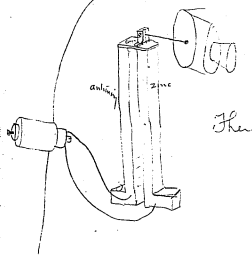
Pt - 5 towards Zinc
Cu 300 "
Rubbing - strong deflection -

Reg No 7 Turned to off - Fe after Eng jumps. Tacking not loud could not read more than 4 inches away — scrapy — squeaks little, requires five manipulations of 1 to 5 ohm — ohmit to obtain maximum — hard to work it twice = The tacking on magnets is low — there may be a ring in this or coils,

Go to page 155

Feb 28th 1919

Glass tube

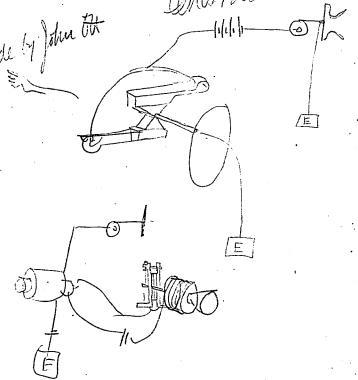


Thermo Junction

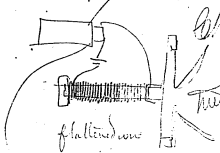
Telegraph telephone Feb 20th 1879 13

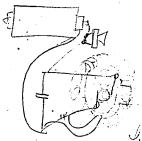
Chas Batchelor

made by John Ott

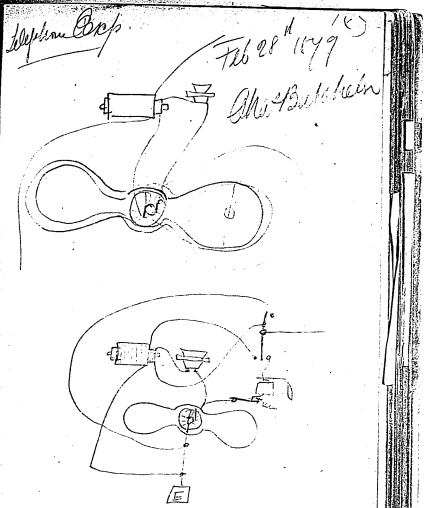


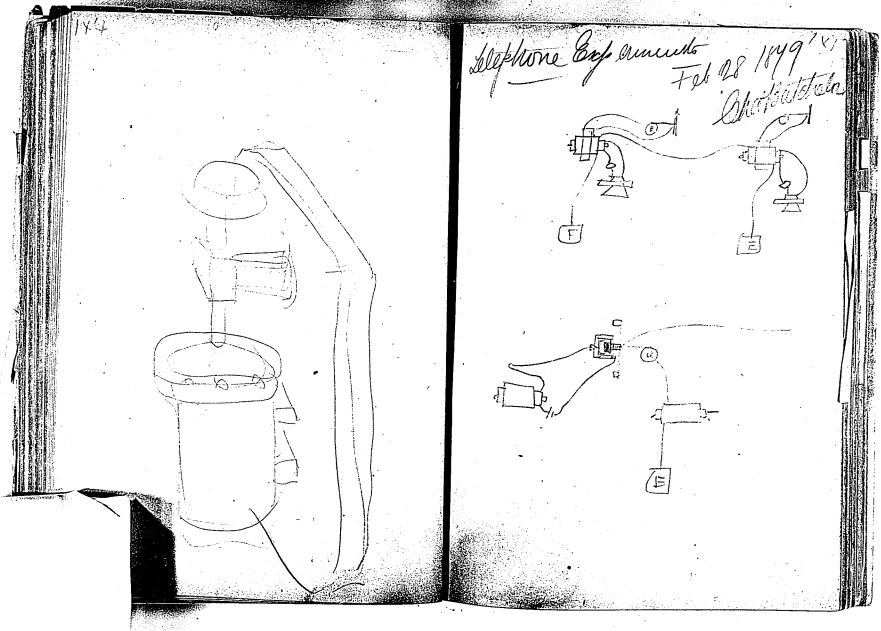
Telephone Exp. Feb 28 1879 [illegible]





Condenser in [illegible] battery




Telephone Apparatus
Feb 28 1879
Charlestown
D
C
F
E
C
D
E

Carbon button Feb 28th 1879. 1x5

Disk 1/2 a dollar

Carbon button warming

Carbon Lamp Black mixed with plumbago =

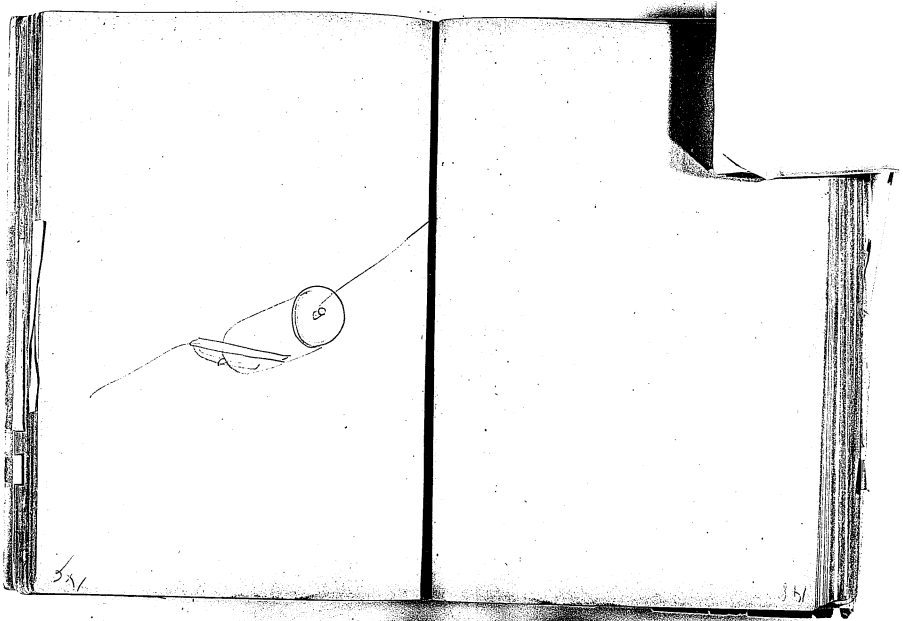
Powdered coke & lamp black cooked with Lamp black =

Retort Carbon button cooked with Lamp Black =

Lamp Black & Plumbago

Lamp Black & dextrine

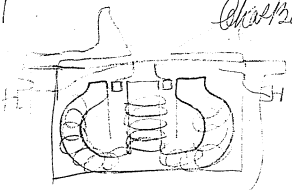
" " Clay



156

Telephone. March 1 1879 - 154

Chas Batchelor



Worked well but not so loud as a Bell telephone
Articulation perfect
Batchelor

March 2 1879

U.S.
Charbatcheler

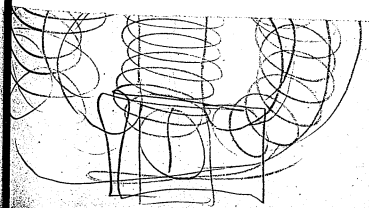
Induction Coils for Telephone

Edison Laboratory Note Book No. 20.

Page 128.

See Edison Patent:

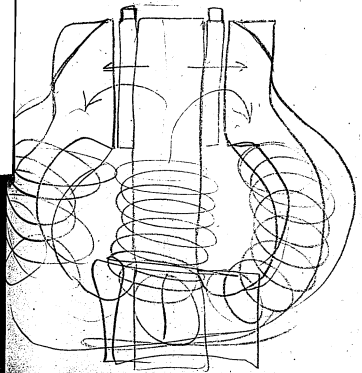
270,128

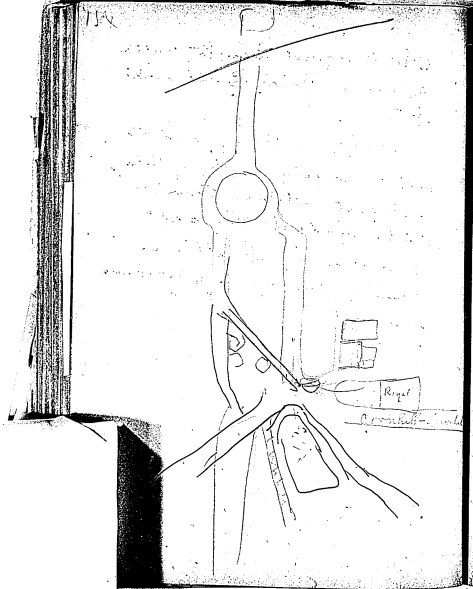


March 2 1879

Tate
Chorbat Ferila

Induction Coils for Telephone

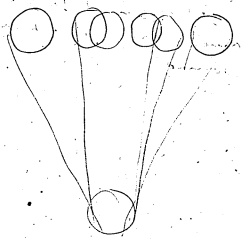




Old Original Bangla Gulta
as near as Golch Could make
it.—

N.B. nothing had to
wet = scarcely anything then,
wet with Shiny Camelia
Seeds made it too soft
after drying it little in
flame & try again. Don't hear
a sound.

16



I never go over all melting them –

No 3 – Chalk H_2O. As much as a man can put on 2 levers,

Portland

3

June, 20 1899

Test for new lot of 180 chalks.

No 1- 4 chalks 3 oz chalk.
9 grams acet Hg- ½ oz
Conc Chl Calcium. EMF action
very strong- Phenomena cannot hear
a single sound, yet Magneto on mouth
is loud ~~+~~ Emf action on chalk loud
After wetting with H2O, dont hear a
mortal Sound yet Emf very strong.
polished.

2nd chalk not a sound Emf action
strong = wet at no sound

Francis left ~~Short~~ ckt Gueton in
July

See next page

160

161

weak. squeaky. Strong Emg action = works with or without P. current. very poor can scarcely hear = All cut up - chopped off no polish.

2nd check. Read 6 inches away best with fuel. P. current, clear not squeaky. not very well polished Cut in one place, Tried weak $NaOH_2O_2$ on it. not so good =

3rd Not quite so good as 2nd Rower Cut a little

Pipe clay – Sulphur – Wet acet.
Chk Calcium. – Nly. soft scarcely
marks a enamel, This is
the celebrated Button prepard
by Prof McLaughlan the
platinum champ assisted by
"Basic"

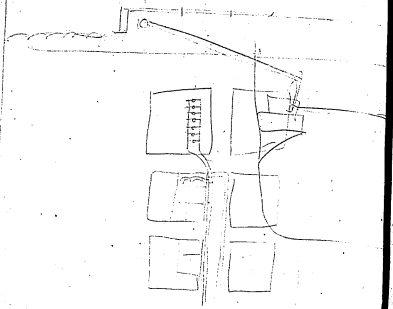
Tripoli – wet walking –
wet with weak $NaOH_2O_2$
very low –

---

4 oz Chalk –
10 grns $CaCO_3$ not found
have to put ear ½ inch from
chaplain to hear – little
diff between Cumnt + no
Cumnt but Emy not quite
strong; little scrapy – polished
but not glassy over

No XX.
Same as other did not wet,
Battery lowered it, talking
good 4 inches away no
scraping - polish nice,
I lay this aside to test
at intervals

Batches Button = Waxy
no grating = low but with
can on sharp no grating a
clear - gets louder, appear
too wet, wants full battery
at first afterwards its not
necessary for full battery.
The second Button with double washer
Mfg. wet strip at too soft =

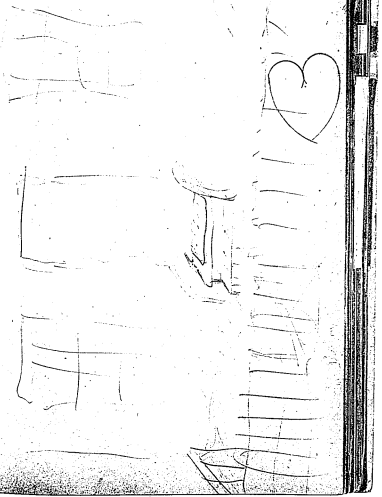


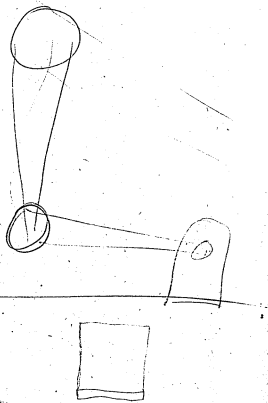
50,

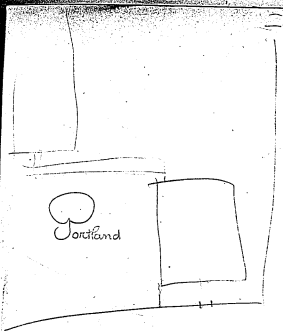
2 oz Chalk - 3 drops FeCl.
10. CaCl. cured read much
away after welling was
lower but very very
gradually got powder
scraping considerable,
polish glassy. Battery
weakened. it,

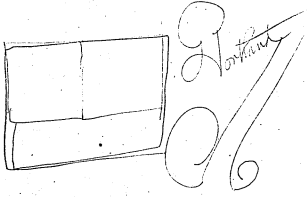
---

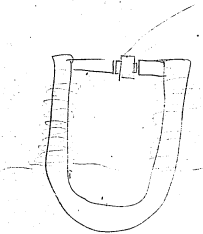
2 oz Chalk.
1/4 - oz H_2O. & 15 drops
$C_2H_4O_2$ = (3 5) Read it with
away = slight scraping - balling
weaken. - I now wet it, it
soon comes up to nearly same
loudness = polished.



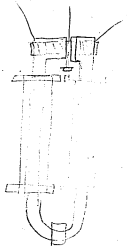



Portland

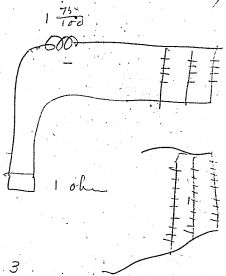


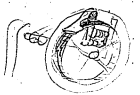


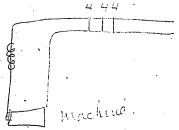
3,



Transvaal Republic


1 ohm




Minchin

178

Maccles 2nd Button (52) -

Can't hear it.

Uptons test

90,000 to 19000 ohms polarizes, it was very long in falling.
(15-cell battery used)

Added Water. Could scarcely hear a sound

Uptons test,

7000 ohms to 8500 — falls to 3000 @ 4500 —
pt + Cu End
Cu 300 to Zn end
Rubbing the least effect of any yet.
Through two or 2 places the groove medium deflection

(53) Chloride Calcium only not a sound of any kind it got moist on outside.

Uptons test,

Very moist.

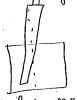
Pt. 100 towards Cu
Cu – off scale to Cu end

5000 – @ 35-00 – then galvanizes,

2 oz Chalk
1/4 oz Caustic Soda.

Loud - old time Ponderosa.

All the change that I can see is that I have shortened sideways



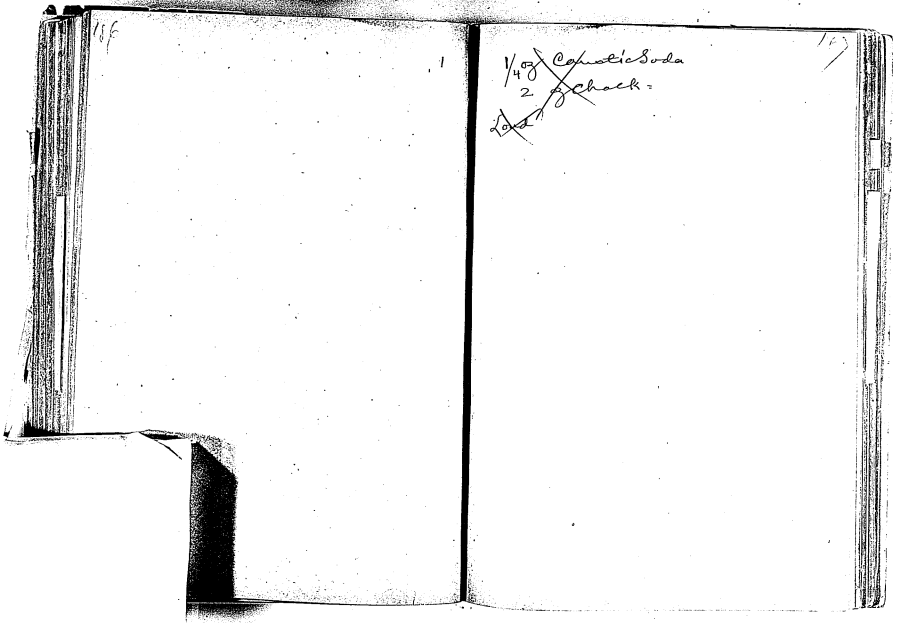
Requires weak current to polarize; no margin negative almost dead current too much. Low — no current Low — and it cuts a groove wider than Pure Platinum =

∴ Upton's Test.

R 1150. falls very quickly to 950. then polarizes very slowly. seems to be very sensitive the short strokes of the key throws enough current through the button to change it.

resolution
Pt — 5 to Zinc
Cu of scale to Zinc
Rubbing on small deflection Black spots on the button when Pt goes in rubbing a shiny deflection

1 oz chalk
1 oz dry Chloride Calcium
natural sound



First one that is any way sound without polarizing battery 2 oz Chalk. 1/4 oz Sal Conc Ca Cl. pretty smooth. & wet it = came so could read 2 feet away - required no battery to polarize. Battery lowered it. Even weakest Current. & put in a new spring other one cut in slightly & became unsoaked with new spring & can use greater pressure. & now wet again with Conc Chl Ca - find that it lowers & requires slight battery but & after wet with H_2O. & it came back to old readings & wet with H_2O again polarized highly.

.2 oz Phosphate Lime
1/4 fl.oz - Caustic Soda

Hardest bullen saw - very low with smooth dilute NaO. Came so could read 3 inch away - not very scrapy not agreeably full current least - Look in awful bat of H_2O before & wet with weak H_2O NaO, - after immersion got dryer a comminuted squeak - & notice that when & put ~~Caustic Soda~~ on a smooth chalk it makes it squeak polished

1½ oz Chalk - 1/2 oz dry
Chl Ca —
Mg.

Chloride Lithia ¼ oz saturated,
2 oz Chalk -
Needs no batting loudest
without batting - wound answer
if all cured be made equal
to it = scraping small,
clear talking, polish nice,
after wetting takes long
time to get loud again

So far I have tested several chalks, having chalk 2 oz NaO. 1/4. these chalk have worked but only so so yet better than anything else. They were mos alike finding that those chalks were not pressed hard I had some pressed hard The first one tried gave talk as loud as I ever heard you could get it with full bathing if you turned somelime or you could get it without bathing. But not so loud the greatest strength was with about of about 2 obtained it worked way I had with light pressure over

Know try another hard '57 pressed chalk =
find it the same

I know try a chalk still harder pressed this requires no water, - and if you deal with no polarization it works Loud & OK =

~~Now~~ I try another & it act precisely the same, we now ~~repo~~ powder chalk 2. up + removed, -

Uptons Test -

first - 2 :
Res 1300 @ 1400 : no change
ohm, very constant
very small changes
Pt - 15 - Toward Zinc
Cu 15.0 "
Rubbing - Throw - off scale : -

over

198

199

Uptons test of

Hand of pressed one, which was not wet.

R 45-00 ohms. goes to 1200 ohms.

slow fall + then polarization.

Pt – 5 Zinc end

Cu 100 "

Pebbling moderate deflections

Finish

Chalk 2 oz Caustic Soda ¼ oz —
1st Chase, pressed very hard 4
men pressure — previously moulded
then sifted & removed, put in
telephone no water put slight pressure
on & turned many times, then increased
pressure & turned many time, increasing
pressure until perfect polished ring
formed — No palonizing Cement
lacking — bowl & Chalk, with great
or small pressure, another Chalk
just like this spoilt by just
willing by heading sponge on &
turning three times around,
Chalk must not be wet after
moulding — this willing dont
loose Tackiness, rather increases
it. But it acts so much just as if
Turpentine was too far away
when if unwet chalk put in
lacking clear — the pressure on

These chalks must at least be 200000 lbs/in. Don't think they will lose moisture owing to fineness & hardness, they get harder the more you work them. Ring nicely galvanised = U

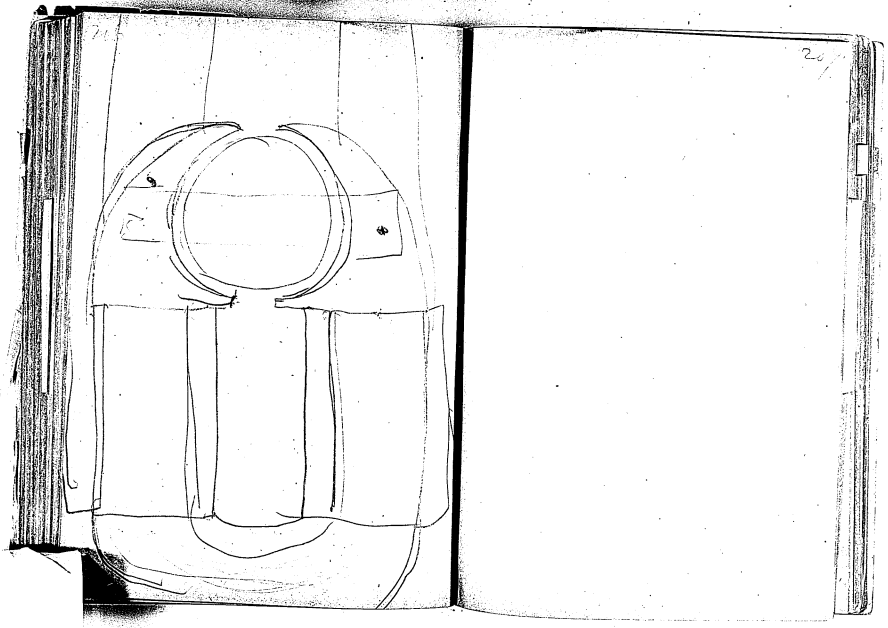
Upton Test

Resistance 9500 ohm reduced by Current (15 cells) through 1000 to 3500. then nearly constant don't seem to polarize.

Pt 5 to 7 in Cu
Cu 5-0 to Zinc End

Rubbing gave small deflection towards Zinc End.

This Current makes a spot by drawing water to the spring & makes it wet.

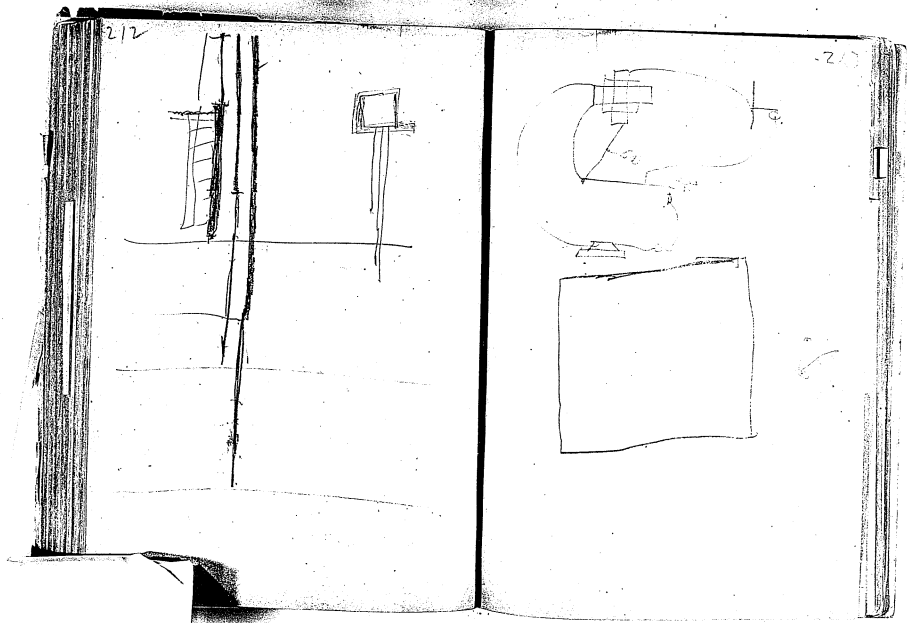


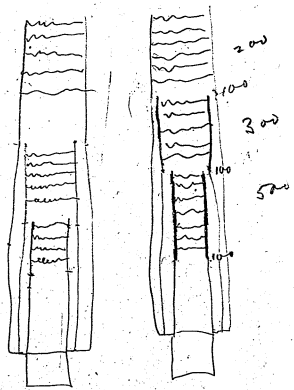
1.12705	2	
1.1 3 1 3 7	.05194	
	9.94633	
	0/1.99827	99.6
99.6 X 1.26572	1.99827	
1.27017	.10216	
	9.99613 -10	
	1.99656	99.2
99.2 X 1.4417	1.99656	
1.44739	.15889	
	9.83911 -10	
	1.99456	98.7
98.7 X 1.67822	1.99456	
1.68667	22955	
	9.77348 -10	
	1.99289	98.3
98.3 X 2.009	1.99289	
2.01669	.30298	
	9.69588 -10	
	1.99122	98.
98. 2.5843	1.99122	
2.5 1 2 9 1	.39870	
	1.89965	
	1.98957	97.8
97.8 X 3.3444	.52436	
3.3561	9.47610 -10	
	[illegible]	

211

100.333	2.00145	5.00084
20.0883	1.30175	.0169
	0.69970	5.02853
50.253	1.70119	3.3447
15.0253	1.17683	.0115
	0.52436 ✓	3.35562
33.562	1.52585	2.5129
13.3562	1.12569	.00961
	.40016 ✓	2.5225
25.2251	1.40184	2.0145
12.5225 1	1.09768	.0976
	.30416 ✓	2.02219
20.2219	1.30582	1.6827
12.02219	1.07998	.00584
	.22584 ✓	1.5885
16.68854	1.22754	1.4605
11.68854	1.06777	.0054
	.15977 ✓	1.4550
14.55089	1.16165	1.2671
11.45509	1.05885	.00
	1.10280 ✓	1.2726
12.17205	1.10451	1.1285
11.27205	1.05300	00
	1.05251 ✓	1.1329
11.32296		

1.12885	3.05251		211
1.13230	1.05423		
Σ .99656	.99828	99.6	2
R .99312	1.10280		
	9.89549 -10		
Σ .99314	1.99657	99.2	3
R .98628	.15977		
	9.83835-10		
Σ .98938	1.99469	98.8	
R .97876	.22584		
	9.77246-10		
Σ .98598	1.99299	98.4	
R .97196	.30416		
	9.69418-10		
	1.99133	98.	
	.43316		
	9.58816-10	97.6	
	1.97765		
	.52432		
	9.47415-10		
32	1.98816	97.3	
	.64770		
	9.34586-10		
94 .97334	1.98667	97.	Cinco
88.5 .94668	2.	96.	Cuarenta
	7.93467 -10	94.	Ochenta
96.674	.98337	93.2	Cinco
93348		92.	Cuarenta
		90.	Ochenta





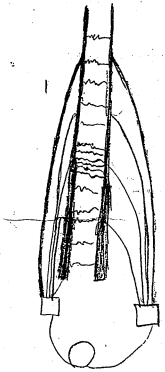
Edison Laboratory Note Book No. 20.

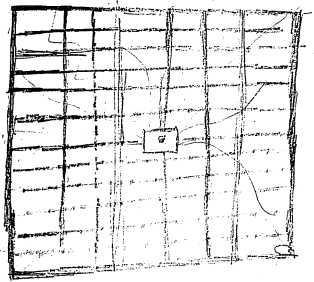
Pages 214 to 218.

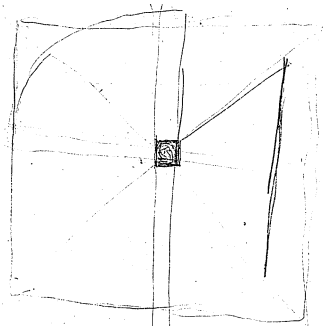
Systems of Electric Distribution.

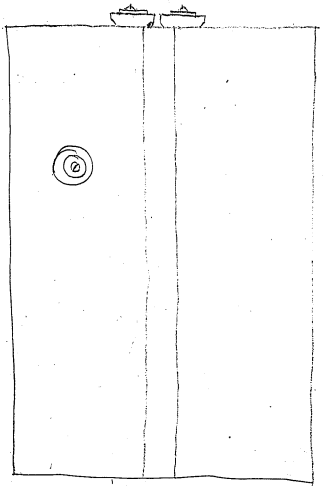
See Edison Patents:
239,147
264,642

2/X
2/J
10'
10'









78 / 9 / 7.03 bushels in an. yard

Suppose $10 expended in conductors for each lamp used at the busiest hour of the day

10

100

.365 ct per day for interest

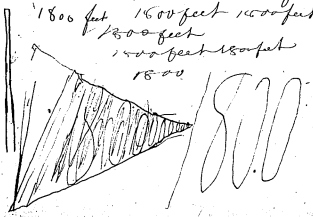
a Station put in centre of a square ½ mile on side longest line

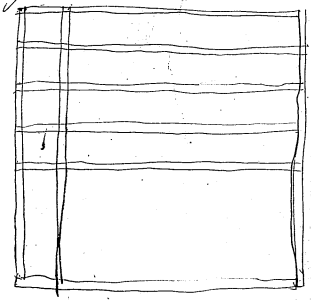
5 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4 3/4

36000 feet

1800 feet 100 for wire

1800 feet 1800 feet 1800 feet 1800 feet 1600 feet 1600 feet 1800 feet 1800 feet 1800





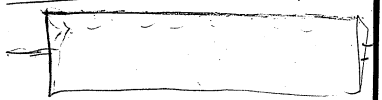
6 inches

363

363

363

363



226

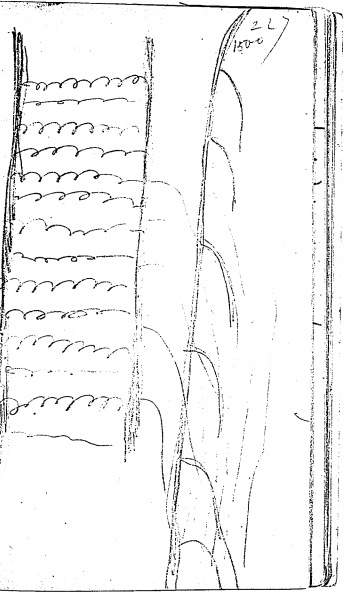
1/4 in. wire

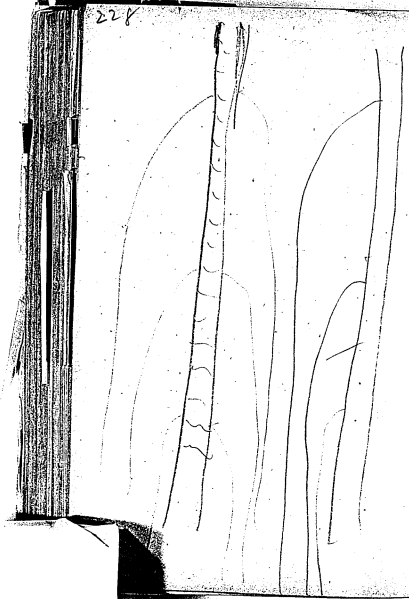
1000 feet costs

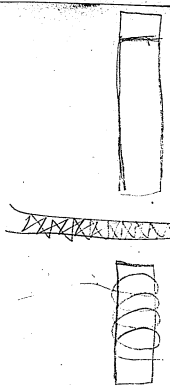
250 20 cts. per

$50.

.2







9 sets of fans x machines and conductors be taken whatever is true of that must be true for the whole system

150 Volts required

150 Volts ½ ohm in machine

30 lights 5 H.P

1 3 ohms in lamp

1/3 ohm in conductor

3.33

3.333 = R

150 Volts

150 2.1761

150 2.1761

Cu 8.83 9.4168

44.3 1.[illegible]

5.1134

26000 4.8866

.5169

7.88 HP

3 .4771

383 .5833

.9590

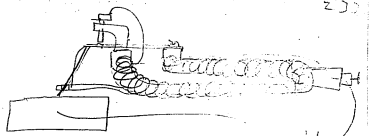
78% [illegible] lamp

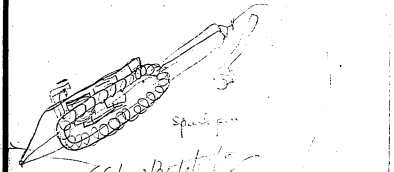
30 lamps in multiple

40 lamps per machine
300 at utmost limit
30 for regular use at
busy hours

Machine $125
Magnetizing machine 25
$150

30 @ $5 per lamp for
machine. Conductor $5





274

$5 a camp interest per day

.50 / 365 = log 1/365 = 7.4377 -10

1/365 = .00274

$5 .80 — .00274 × 5 = .1370 cts. per day

$6 — .00274 × 6 = .1644 cts.

$7 — .00274 × 7 = .1918 cts.

$8 — .00274 × 8 = .2192 cts.

$9 — .00274 × 9 = .2466 cts.

$10 — .00274 cts.

$11 — .274 × 11 = 274 + 274 = .3014

$12 — 274 × 12 = 548 + 274 = .3288

$13 — 274 × 13 = 822 + 274 = .3562

$14 — 274 × 14 = 1096 + 274 = .3836

$15 — .274 × 15 = 1370 + 274 = .4110

$16

274
16
1664
274
.4404

$17

274
17
1918
274
.4658

$18

274
18
2192
274
.4932

274
2
.548 cts per day

$25

(27400
.685 cts

$30

274
3
.822

If thirty dollars were invested to pay for a lamp conducting machine, ~~at the track was~~ this being for the ~~year~~ use at the full hours, it would be .72 cent per day for interest a 10 ~~per~~ cent

for E.L .375 would be received per hour

at 6 per H.P. profit cost 2 cts an hour

.333 cts for cost.

Gas 5 feet

$1.00 a Thousand

1/2 ct an hour

E. L. must be sold at rate of 75 cts. a thousand to introduce it as against gas even at present prices.

Reasons. people must have light and would be very slow of changing if there was any danger of the light being ~~in~~ ~~ingnited~~, or disturbance of chandeliers or walls.

$\frac{3}{4} \times \frac{1}{2} = \frac{3}{8}$

6 per H.P
2 cts per hour

8)3.00
.375

375
.333
.042

At ten per H.P. .2

These lamps may be put in the same conductor. If by any means the lamps are only put out part of the time. The difficulty in this would be to regulate them each. If the "jigger" should stick for a moment the lamp would burn away. On the principle of regulating the E.M.f. so that the lamps may never burn away. This cannot be done at all. The only way then is to turn the lamp intensity on

Ten per H.P. are needed to make the E.L. a ground success. The following experiments are need to be performed.

Testing regulator or jigger

Testing E.M.F. of ~~from magnet~~ and power obtainable with magnets.

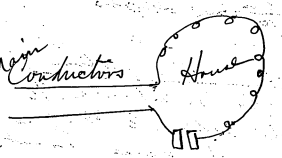
Testing motor

In testing metre fluid
next 2nd Whether the plates
change in weight by immersion
in the fluid. 2nd shows
small amount of current
may be measured on ash tube
I like to see how
exactly a small amount of cur-
rent may be weighed this experi-
ment seem very easy

10 Lamps per H.P.
10 Lamps per H.P.

Question is a contrary
E.M.F. the same for
subdividing as a resistance
on which the same amount
of energy shall be given
off and the laws of the
same.

I think not.
Yet, in a machine
as in a lamp the E.M.F.
falls gradually
But the law of
the distribution of
energy is different.



Nine 10 Ohm lamps and
1 Ohm motor

100 Volts E. M. F.
Each lamp 3300 ft. lbs
or 1/10 H.P. 4430
The same current must
be the same

100 Volts

$\frac{100}{100 \times 10^{-8}} 44.3 = 44300$

1 lamp and motor

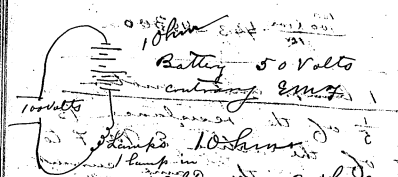
$\frac{1}{5}$ of the resistance $\frac{1}{5}$ of the active E. M. F to produce the same current over resistance

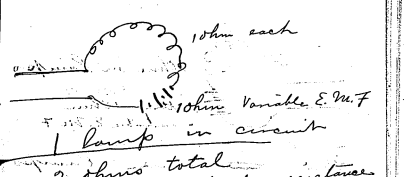
4 lamps in series = 80 Volts
Fall due to resistance 20 Volts
" " motor E.M.F 80 "

Distribution of energy

2 or 1 in lamp and resistance
8 or 4 " motor

1 in lamp
9 " motor





2 ohms total

1/5 of resistance against when all the lamps are in and nothing but the resistance of battery without E.M.F.

Therefore 1/5 of the active E.M.F. will give the same current

20 Volts active E.M.F
80 Volts contrary " " "

Distribution of work

2 in resistance
8 in work in battery
1 in resistance of lamp
9 in resistance and E.M.F of battery

When ~~all~~ three lamps and battery are in circuit E.M.F. for 100 volts. ~~one lamp goes off~~

44 30 ft lbs

E.M.F. 3

4 lamps in

$\frac{1}{2}$ the resistance

$\frac{1}{2}$ the ~~—~~ E.M.F.

50 Volts active

50 Volts contrary

~~550000~~ ft lbs on 4 lamps

$$\frac{50 \times 50}{5} \times 44$$

$$500 \times 44$$

$$22000$$

$$4400$$

$$17,600$$

On four lamps

48 4 candle gas jet.

$\frac{1}{2}$ inch .020 2½ Ohms

~~6~~ 40

6.2
6.2
124
372

.020
.020
000
126
.126

6.3) .020 (.33
189
210

.003.3

20
20
400

3.3
3.3
99
99
10.89

9.9
4.9

6 Sprague about
75 lbs
4 150 lbs there and back
12 $ 37.5 Edisons House
$ 4.10 hr Camp about
$ 1.00 Camp to Office &c
500
$ 250 average

1/8 3/8

1/16 X 3/8 = 9/128 = 3/43

= 1/14

2/32 1/16

1/16 in surface on Jablochkoff.

1/16 1/32 15

1/92

Thread

Oct. 22, 1879.

~~200~~ Electromotive force requisite to run an 100 ohm lamp when N lamps are obtained by three power

$$\frac{E^2}{R}\,44.3 = \frac{33{,}000}{n}$$

$R = 100$

$$E^2 = \frac{100 \times 33{,}000}{n \times 44.3}$$

33 000,000 | 6 5185
44.3 | 1.6464
2 | 4.8721
2.4360

$n = 1$ 2.72 Volts

$n = 2$ 4.8721 · 3010 = 2 | 4.5711 = 2.2855

193

$n = 3$ 4.8721 · .4771 = 4.3950 = 2.1975

157

$n = 4$ 4.8721 · .6021 = 4.2700 = 2.1350

136

$n = 5$ 4.8721 · 6990 = 4.1731 = 2.0865

122

$n = 6$ 4.8721 · 7782 = 4.1099 = 2.0469

111

$n = 7$ 4.8721 · 8451 = 4.1170 = 2.0585

104

$n = 8$ 4.8721 · 9021 = 3.9690 = 1.9845

96

$n = 9$ 4.8721 · 9542 = 3.9179 = 1.9589

91

15 4.87721
1.17761
2 | 3.69960
1.84480 70.

16 4.87721
1.20241
68 | 3.98680
1.83420

17 4.87721
1.23014
3.64117
1.82068 66

18 4.87721
1.25553
3.61686
1.80844 64.

20 4.87721
1.30116
3.57711
1.78855 61.

n = 2.5

4.87721
1.39779
3.47742
1.73711 54

30 4.87721
1.47771
3.39950
1.69975 50

40 4.87721
1.60021
2 | 3.27700
1.63350 43

50 4.87721
1.69990
3.17731
1.58865

60 4.87721
1.77782
3.09939
1.54969

Estimate of Cost

~~Estimate~~

3 15 HP
Horse power $90
Boilers $18
Land &c $15
$123

Dynamo machine $150
6 per H.P. when all are on
10 hrs of power delivered by
machine
3 sets 15 Candles
~~$5 x 8 per c~~
$50 p H.P
Lamps & Shades
5-6 per H.P

$223 per H.P invested
6 | $22.30 per year per H.P.
$3.82 " " per lamp
1 ct per day per lamp
5 feet of gas
1000/5 = 200 $1.00/200 = ½ ct.
2 hours a day average
1 ct per hour

If the
want confirmed on
Hay,

1

1 Providence 10th

But will

es. but will have to order

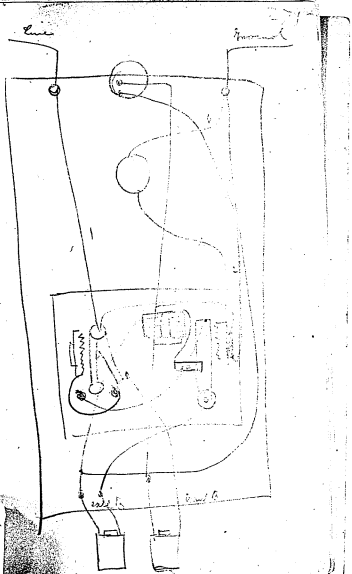
wire specially and can't

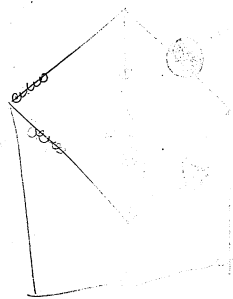
send before middle of

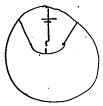
next week answer if wofshall

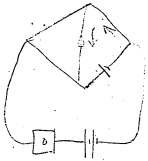
and if so

found ?

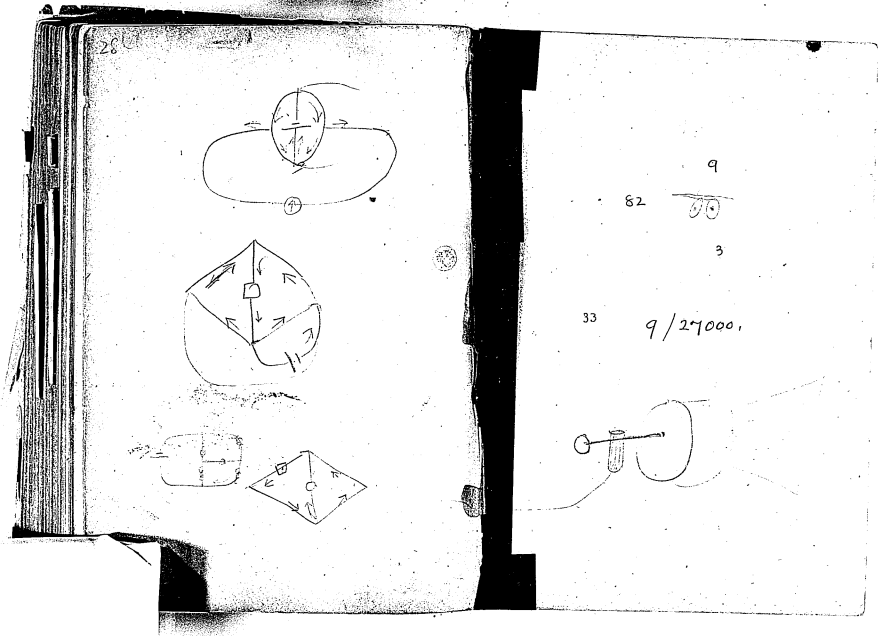








772
77209


26
9
82
3
33
9/27000.

Thomson
Caveat

Menlo Park Notebook #21 [N-79-04-08.1]

This notebook covers the period April-October 1879. The entries are by Edison and John W. Lawson. Included are notes, drawings, and calculations for a series of experiments on thermoelectricity. The experiments were made with bars of metal alloys and are probably related to the alloy experiments in Menlo Park Notebook #18. The label on the front cover is marked "Thermo Experiments." The book contains 284 numbered pages.

Blank pages not filmed: 158-161, 202-203, 208-215, 218-271, 274-277.

Missing page numbers: 7, 9-13, 15, 17 [pages 7, 13, 15, 17 were renumbered as 2, 3, 4, 5].

MO 24

GENERAL ELECTRIC

, 189

Experiments on Thermo electricity

April 8 1879

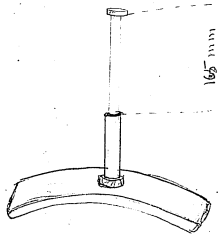
We have cast about 100 alloys and are casting several hundred more. These alloys vary by 10 per cent and besides we are to make alloys of the metals with the Arsenides, Selenides, Phosphides Sulphides, Tellurides, and also bars of powdered metals oxides, etc moulded under hydraulic pressure. These bars are 120 mm in length and .12 mm thick. with holes in the ends. The bars to be tested are connected

together by a copper strap. Thickness
2¾ mm length 28½ mm breadth 14 mm
copper screws are used to secure the bars
together on the strap. the distance between
the bars after they are crimped is 3 mm
at the other extremities holes are drilled
in the sides 10 mm from the end into
which the wires are inserted holes
drilled in the end have screws which
clamp the conducting wire, The
sulphides and brittle metallic alloys
have clamps instead of screws

both to secure them together and to secure the cores this device will be explained further on.

As a source of heat I used a cube of copper with boiling water and the couple was screwed to the side of the cube by a projecting screw which entered a threaded hole in the copper strap connecting the Thermo-couple together. A Thompson Mirror Galvanometer with coarse wire was used the resistance of which is

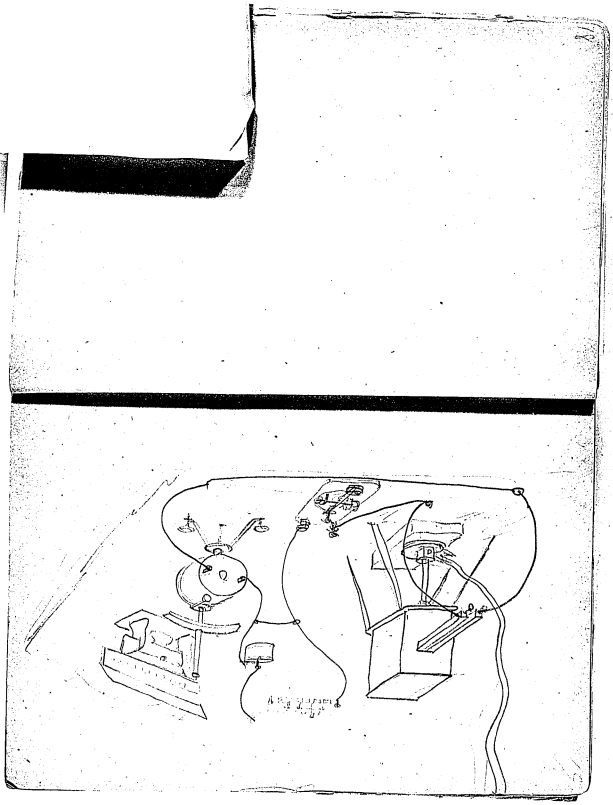
_____ ohms - distance between the face of the galvanometer case and the scale 500 mm. directing magnet



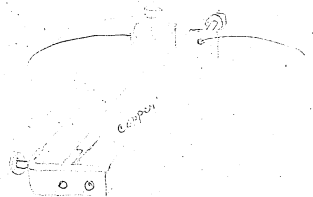
as shewn above. under these conditions one Daniells cell gave a deflection of two degrees through 1820 ohms

150 degrees through 1245 ohms
deflection of 200 through 930 ohms
deflection of 250 degrees through
757 ohms deflection of 300 degrees
through 642 ohms deflection of 350
degrees through 559 deg.
deflection to the left =
After taking these readings we find
we had a thermo Galvanic current we
take the readings again

Deffection	100	1870	ohms
"	150	1270	"
"	200	965	"
"	250	780	"
"	300	670	"
"	350	570	"



we test every metal against copper and allow it to gain a constant temperature before taking the final reading - we have concluded to use the copper clamp both for securing the wires and the bare together.



Boiling water

Readings
14

Copper and Brattleman 22 deg

Thermometer left in cover 2nd — 25 "
14 mins

3rd " 25 "

We now put them on for 10 minutes & then take the reading. copper on constantly

No 77

Copper & Copper 20 oz brass 6 oz on and put on 9.35 pm. Copper is the same—

Reflection to night 1st reading 90
2nd " 92

No 68. - 70 per cent of copper 30 pc of Antimony —

9.45 AM —

Deflection - 1st Reading 60
To the left = 2nd " 65

Nos 69. 10 per cent copper 90 pc of zinc

10 AM 10.15

Deflection - 1st reading 115
to the right. 115

I noticed that after 5 minutes of gave deflection of 132 This shows that the bars gradually expand heated at the finding post ends

No 23 - Sulphide ~~Lead~~ Copper

1023 pm.

Deflection - 1st Reading

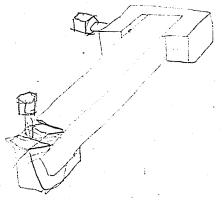
35°	through	100	ohms
65	"	50	"
128	"	25	
300	"	10	"

Keeps same deflection after 10 minutes. The sulphide seems a very poor heat conductor and is scarcely warm even close to the junction while the copper is hot at the extreme end. The galvanometer is thrown violently off the scale with no resistance in -

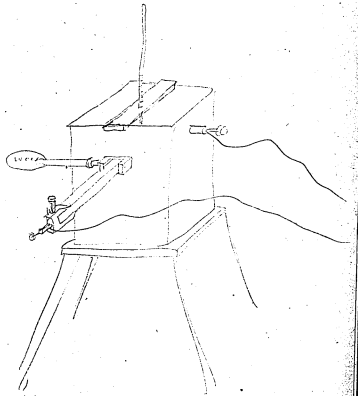
April 8. Evening - 7.15 pm

Resumption of Thermo-experiments

We made a new clamp



We use the copper cell itself cut the other bar see other page

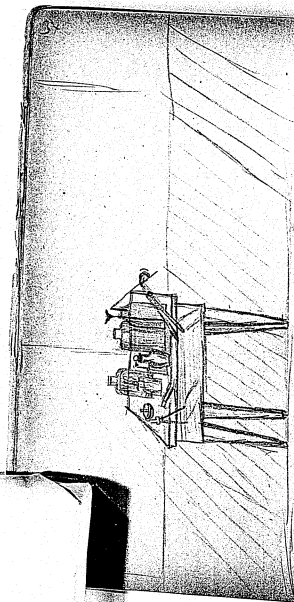


We try 23 Sulphide Copper again & 33
find it goes the same (10) 35° deg
through 100 ohms = Deflection to left

No 24 - Sulphide Copper goes for 2
minutes goes to the left =
12 deg in 4 minutes (not full length)

24 - another piece marked 24 but
mineralogenesis - Sulphide Copper
goes of the scale, goes to 18 to
the left through 100 ohms

30 — 30 per cent Copper 70 of zinc
deflection 24 to the right minus —



No 61. Sulphide Iron deflection 31
of ~~[illegible]~~ 115 to the left. no ash

67. 20 per cent Copper 80 per cent
of Antimony - deflection to the
left of 15 - no R.
~~Stuff at base~~

67. 20 per ct copper 80 antimony
deflection 3. to the left

65 - 40 per ct copper 60 antimony
deflection 2 to the right.

68. - 70 copper 30 antimony
7 to the left -

71 - Short Bar — 10 per ct Copper
90 per cent Lead — deflection to
the left of 25.

74 — Copper 60 pc Iron 40 pc
Deflection to the right 16.

75 = Copper 50 pc - Iron 50 pc
deflection to the right of 15

76 Copper 30 pc Iron 70 pc
Deflection to the right 22

77. Copper 20 pc Iron 80
Deflection to the right 20,

78- Copper 10 pc Iron 90 pc 39
Deflection to the right 26 -

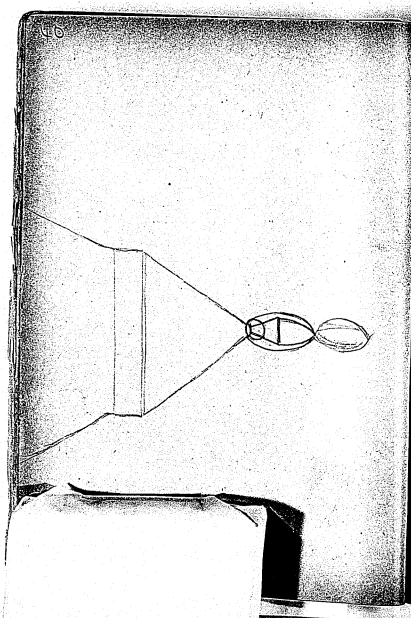
60. Bell Metal - 69 pc Copper
Tin 31 per cent, Deflection to
the right .8 deg

No 1. Steel - Soft -
Deflection to the left of 8.

No 1 again 2nd bar.
Deflection to left of .7.

No 2. Steel hardened to Blue.
Deflection to left of .9.

No 2 2nd bar -
Deflection to left .8.



No 3. Steel - hardened to a shaw 4/
Deflection Nil Def to left

Same - 2nd Gas.
Deflection 2. Def to Left

No 4. Steel glass hard
Deflection to the right 7

Same: 2nd Gas
Reflection to the left 5

No 5 - Steel glass hardened ends
Def to Right. 10 9 reverse
Ends - goes to the left 5 deg

Ditto 2nd Gun goes to the 45 right - 11

No 6 - Soft Iron -
Kick to left 20 deg

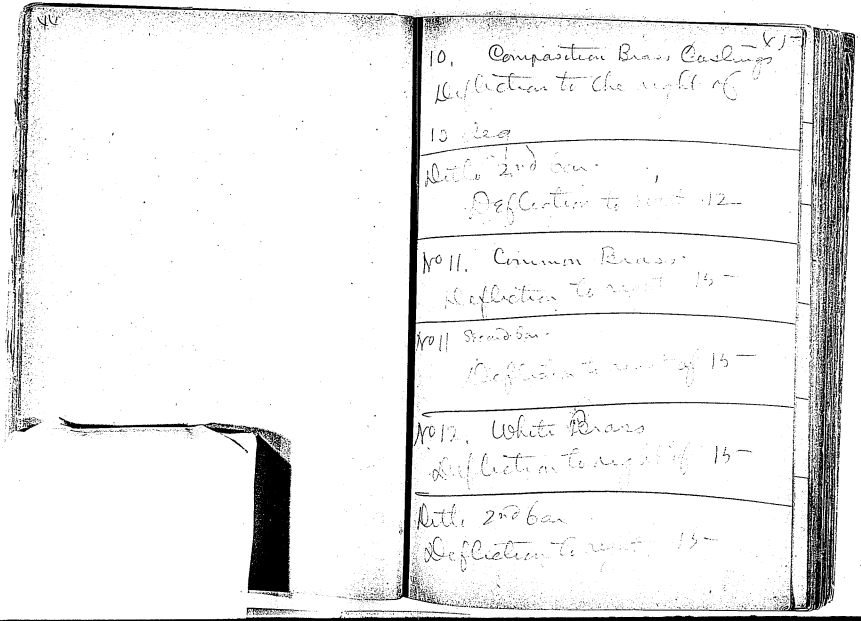
No 6 2nd Gun -
Deflection to left. 20.

No 7. Iron-Hard
Deflection to left 22

No 7. 2nd Gun.
Deflection to left. 22

No 8. Cast Hardened Iron
Deflection to left. 20

Ditto 2nd Gun
Deflection to left. 18.



13. 70 per cent Copper 30 pc Zinc
Deflection to right of 12

14. 60 Copper 40 Zinc
Deflection to right of 11

15 - 80 Copper 20 Zinc
Deflection to the right 13

16. 90 pc Copper 10 Zinc
Deflection to right of 13

17. German Silver
Deflection to right of 45 -

Ditto 2nd Ca —
Def to right of 45 —

18 — Pewter
Deflection to right of 71

Ditto 2nd Ca
Deflection to right 10.

19 — Brittania Metal
Deflection to right of 12

Ditto —
Def to right of 12

20 – Zinc
Deflection to right of 9

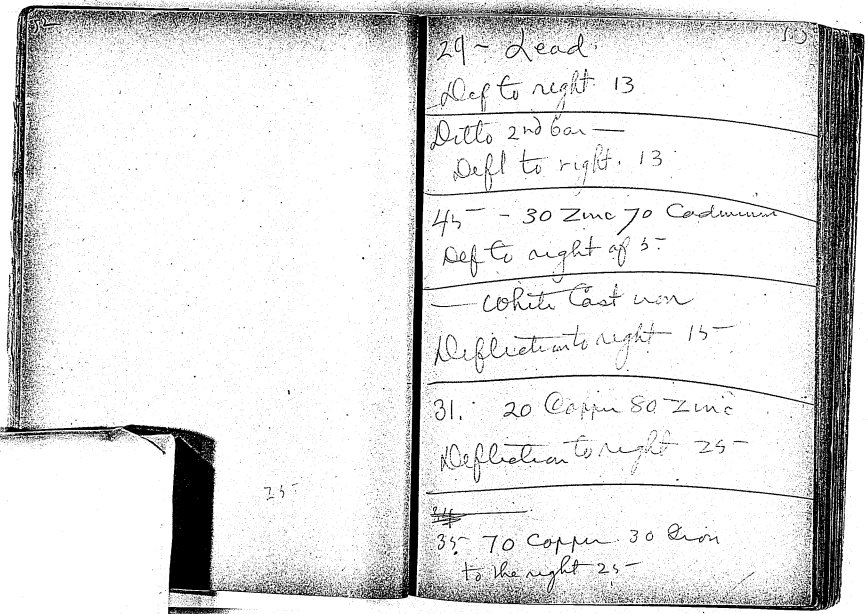
Ditto 2nd 6an
Def to right of 10

22 – Grey Cast iron –
Def to right of 28,

Ditto 2nd 6an –
Def to right 28

25 — 50 Copper 50 Zinc
Deflection to right 12

28, 40 Copper 60 Zinc
Def to right 15



29 ~ Lead.
Deft to right 13

Ditto 2nd bar —
Defl to right. 13

45 — 30 Zinc 70 Cadmium
Def to right of 5

— White Cast iron
Deflection to right — 15 —

31. 20 Copper 80 Zinc
Deflection to right 25 —

~~24~~

35 70 Copper 30 Iron
to the right 25 —

25

36. Babbitt metal
Deflection to the right 5—

37 — Tin.
Deflection to the right 11

38 — 90 Zinc 10 Cadmium
Def to Left. 185

40 — 80 Zinc 20 Cadmium
to the right. 5—

41. 70 Zinc 30 Cadmium
to the right. 5—

42 — 60 Zinc 40 Cadmium
Def to right 4

43 — 50 Zinc 50 Cadmium
Def to right 5—

44 — 40 Zinc 60 Cadmium
Def to right 5—

46 — 20 Zinc 80 Cadmium
Def faster than 2nd Nil

47 — 10 Zinc 90 Cadmium
Def Nil

48 — Sulphide Tin (Proto)
Def to right 12

Ditto, 2nd Gen —
Diff right 12

50 - 10 Copper 90 Zinc
Deflection to the right 10

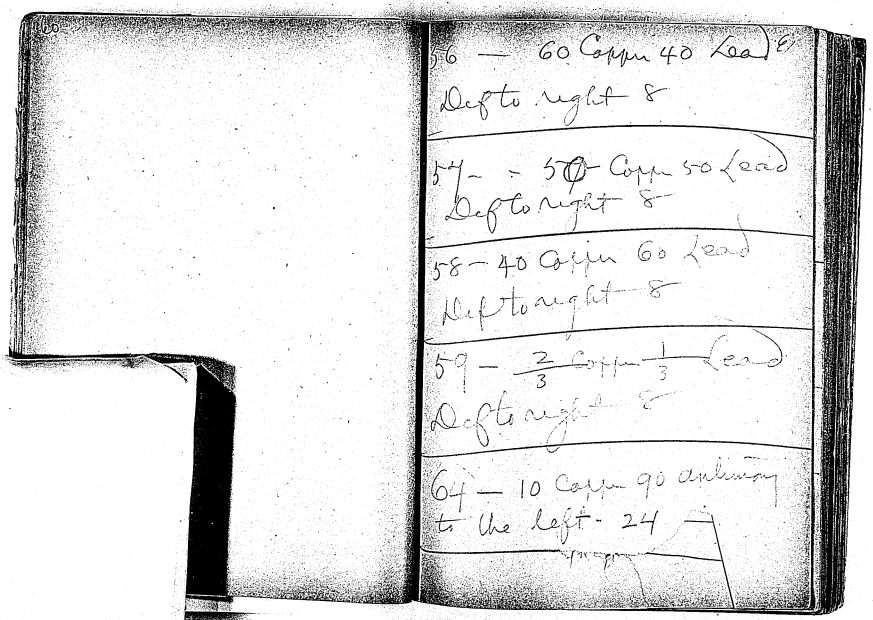
51 - 50 Copper 20 Iron
Def to right 18 Deg nat
well mixed

52 - 30 Copper 70 Lead
Def to right 10

53 - 90 Copper 10 Lead
Def to right 8

54 - 80 Copper 20 Lead
Def to right 8

55 - 70 Copper 30 Lead
Def to right 9


56 — 60 Copper 40 Lead
Deft to right 8
57 — 50 Copper 50 Lead
Deft to right 8
58 — 40 Copper 60 Lead
Deft to right 8
59 — 2/3 Copper 1/3 Lead
Deft to right 8
64 — 10 Copper 90 Antimony
to the left - 24

69 – 80 Copper 20 antimony
Deflection to right 5–

70 — 90 Copper 10 antimony
Def to right 10

71 – 10 Copper 90 Lead
Def to right 11

72 – 20 Copper 80 Lead
Def to right 9

73 – 20 Copper 80 Lead
Def right 10

April 9 1879. 65

Miscellaneous Experiments with rough Masses, not very reliable,

A Crystal or Cube of native galena 1/4 inch square on the 212 Copper Wire Cube shown. The light to the right of the scale, artificial Galena to the left of scale.

Lake Superior Stamp Sand Left right to dog

Deluc from Portlo. 20th right 9 distinct weights very good Contact

Stock of fused Tellurium about 6/
3/4 inch long 3/16 diameter went
off scale to the left - 100 Ohms
mounted brought it to 55. +
175 Ohms to 35° which is the
same as artificial sulphuret
of lead with 100 ohms in

Chromium from J M & Co
15° to the right -

Lime ore from Bruze Lode
Nevada Dist. (Colorado group)
gave off scale to right - (some
power goes to left)

Sulphide Bismuth about 30°
to the right

Sulphide Antimony to left about 125°

Solid Sodium amalgam 18 to the right

Native Arsenic (from Foote) 40 to the left.

Samaltite. from Schweitzer's Jacksonville 25° to the right

Cuprite from Colorado. Mel too much Red & Black

Brookite - (Ti) from Magnet Cove Ark. Mel. too much moisture & Black

Magnetite. F Fe.
Lodestone, from magnet
15° to the right - greenish
Control R.

Allemontite. Sb - As$_3$ -
Allemont France
whitish part goes 300 to the right
compact & darker part 50 to the
left -

Ullmannite. Prussia
50 to the right

Stibiconite, Var - Pantzite
Mono Co Cal - 50 to the Left

Bornite - Eulysite, Horsejo
ore Chili S.A. 150 to the left

We melted the natural Sulphide of Lead to a streak and stood thrown the light off the scale ~~which was~~ to the right while the artificial Sulphide of Lead threw it off the scale to the left

Silver ore =

Lead Sulphide

to the left

Include Copper Ore to the Left

We found that after many Experiments that fused quartz only goes to 350 instead of 400 as it does to the right but unfused Quartz goes to 450 to the right Tellurium went to 50 on the left the two together went to 95 on the right

~~Silicon (Si impurity)~~

~~Copper~~

Fused Silica Bar [illegible] jumps - 100 to the right Varies in different parts

Battery Current 2 to the right – Clamps well & good Conduction obtained –

Silicon (rough Ex) goes to left about 250 deg increased by pressure Think This is Very Sensitive

Electromalograph points on Thermo. Tests

Cobalt	10	to right
Lead	1	"
Gilson	12	"
Tin	3	"
Zinc	3	"
Arsenic	12	Left –
Antimony	10	"

Tellurium 150 to Left
Aluminum Undecided Left Mid
Thallium 5- to Right-
Indium 2 "
Nickel 15- Right
[illegible] 5- "
Bismuth 20 "
Platinum Salts 10 "
Brass 5- "
[illegible] 3 "
Magnesium 3 "
[illegible] 5- "
Fe Sulphide Tri 4 "
Sulphide Bro 50 - to Middle Chrom
than the other -
Silver 3 Right

Sulphide Copper 1 Right

Chromium 10 "

Iron C.P. 1 Left.

Canes Carbon 2 Right.

all of pours

Metals in Case

Rhodium 2 Right

Rhodium 2 "

Zirconium 5 Left

Cubanite.

from California

goes offsets to Right

Augite magnetite
Magnetite Crystals 20 to Right

tetrahedrite
San Juan Co Colorado
50 to Right

Pine Cabinet

Macaronite 153 - 130 Forte
Bad Cabinet - 1 place given to 150 to right

Marcasite. Cabinet [illegible]

Powered Black Oxide ... mixed with Monel 3/8 diameter 1½ inch long pressure 150 and 400 lbs – don't appear to collect ...

Mercuric Sulphide ... mixed made by Mack Entire : goes to right 28.

¼ as much
Tetra Sulphide ... mixed made by Mac – 20 to right.

½ as much
Hama Sulphide ... mixed made by Mac 10 to right

66

25

9 find that Our Key has had a Capricious resonance in the [illegible] all these [illegible] resonance @ Ce -

Without Key -

Tellurium through 100 ohms goes to 50 to the left

Cube of Nature P65 goes 48 to right -

Sulphide Copper 35 - to Left.

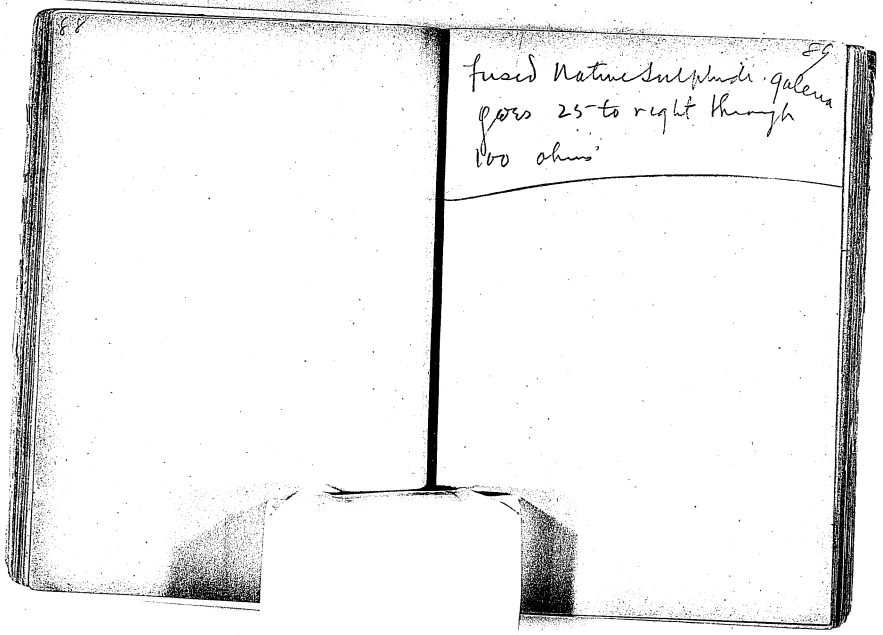
Fused Sulphide ~~Of~~ Lead ~~of~~ Without 4 - to right.

All Chromyls 100 ohms

Bismuth 14 to right -

Cube of [illegible] from

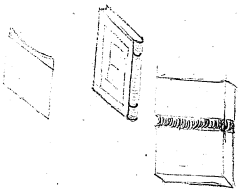
Joplin Mo [illegible] 30 to right through 100 ohm


fused Native Sulphuret · galena
goes 25-to right through
100 ohms

April 10 –

For some unknown reason the galvanometer is more sensitive this morning probably the [illegible] [illegible] [illegible] has weakened Bismuth Copper gives 50 – [illegible]
Copper gives 50 – [illegible]
Bismuth 10 right – Tellurium 4-5 left – Thorough 100
Others This seems to be better for Sul Copp

Same for Tellurium gives this increased deflection with Sulphide Copper is due to larger mass which has got cold while Te & Bismuth was quickly warmed



both by hand & by the Cube -
this accounts for it -

Fe 80, Tungsten 20 pc
no deflection through 100
ohms 100 ohms no resistance
to the right -

Sulphide Cadmium 50 pc
Sulphide Lead 50 pc
goes to 15 to right through
100 ohms. while Art Proto Sulphide
Lead only to 5°.
Cube Galena goes to 45 to
right.

(through 100 ohms)

Graphite Natural, nix through 100 ohms

Hematite, from Stoperning Mich reading through 100 ohms

Magnetite nix

Zincite, from Franklin NJ in one spot 15 to right 100 ohms

Pyrosmalite from Georgia 5 to right in spots. 100 ohms

Bestwet

Chalcopyrite $CuS.FeS_2$ from Chili - goes to 100 to the right. on 100 sheet

Sorbentube, neg.

10 per cent. Zinc 90 per cent of antimony - 10 deg to the left. through 100 mesh

40 per ct Zinc, 60 antimony goes to 18 to left through 180 of

20 per cent Zinc 80 antimony
8 to the left through 100 ohms

30 per ct Zinc 70 antimony
12 to the left through 100 ohms

20 pc Copper 80 antimony 3 to
the left 100 ohms —

Copper & Tin Sulphide
Equal parts. 10 to the Cell
through 100 ohms

Has high resistance
bar is porous when 9
connect near Cube & goes
35° to left through 100 ohms
3 of 9 put it quite close to it
just a little much more to
put it 2 inches from the
Cube Clamp. Is a Good
bar

Foote Tin Sulphide 9 to left
through 100 ohms

Chalcopyrite from Colorado
also in spar goes to 50,
with 100 ohms

Arsenopyrite, or Safflorite,
or pyrrhotite in spots goes
jump to right to right

Sulphide Antimony 8 G.
the left through 100 ohms
without quartz boiling

Same. Boiling

2 grams Cadmium Sulphide
18 g " Lead "
goes 20 to the right on 100 ohms

16 grams Lead Sulphide
4 " Cadmium "
goes 8 to the right 100 ohms

Silicon goes to 40 on
left 100 ohms 4 to the right
[illegible] covered part [illegible]
[illegible] goes to the right
try in a tube

Thalofide was small
Shaving ½ to the right
through 100 ohms

27 grams Copper Sulphide
15 " Iron "
2nd powder
8 to the right

27 grms Cu_2S
15 " Fe.S. two ohms
2 " Pb.S.

3 to the right

23 grms Cu
4 " Fe two ohms
6 Sulphur

3 to right

28 grms Cu
7 " Fe two ohms
21 S.

10 to right

23 grms Cu
21 " Fe
46 " S
100 ohms

5 to right

54 grms Fe
108 arsenic
100 ohms

Unknown Sulphide One Metal
MC Sand over Galena
Mineral Pb, Sb as oh of
Allemanite over to 28 -
to right on 100 ohms

Dont get deflection with
Metallic Arsenic in
100 ohms

Selenium Pb made
by making Pb anode in
Selenium good short 10
to right

Phosphide Cathode
4 to the left through 100 ohms

80 Pb. 20 Cd. Mix -

70 Pb. 30 Cd Mix
30 Pb. [illegible]
through 100 ohms

90 Pb 10 Cd – smooth

50 Pb 50 Cd – mix

40 Pb. 60 Cd. mix

60 Pb. 40 Cd. mix.

Boiled in Copper ni
trate solution Copper plunger
gave 15° to 16° reaction
and of 9 Cu. gave 8°
action 140° to right they
died away upto 120 deg
out & Items observe 15°
to left

Reduced Manganese
Acetate to 10 to right
[illegible] powder
by Cu Cl plate
and 100 Ohms

Ni Sulphate Tin Chloride
Cu Cl Cu Cl
powder

Bronze Gold powder Zinc
+ Tin - Four Each Thing
Reg.

Ores

Magnetite. Essex Co NY
2 to right

Pyrite. $Fe.S_2$ - 40 to
Virginia
the left - nice sample -

Chalcocite. Utah -
10 to left.

54 grms Cu. 108. Arsenic
NG.

22 grms Fe,S.
15 " Cu, Metallic
N.G.

Copper Arsenide & Iron
Equal parts - N.G = Tin nice
alloy

Cu Arsenide.
Cu sulphid. Equal parts
5 to left Nice Alloy

---

75 grms Lead
30 " Arsenic, N.G

---

38. grms Antimony
62 " Arsenic
N.G

120

121

70 grms Bismuth
5 arsenic,
10 to right

34 – grms Cadmium
24 . Arsenic = 10 to right

Al_2O_3 – Zinc
Sulphide Sodium – Charcoal
mly

20 grms Feldspar
20 Cu. S. mly –

Sulphid Fe + Copper Nickel
heated long time mly

heated skillmore
NG

24 grms Fe.
18 " S. NG

18 grms Cu_2S
26. Fe.S. (magnetic.
10 to left

Molybdt - Cu.S. Fe.S.
Pb.S. Bi.As - Cd.As -
Cu.O. Feldspar. Sulphur
10 to right

Sulphuds of Copper

(23) Sulphuds of Copper	(1)	Soft Steel	5
" "	+(2)	Blue Steel	5
" "	" +3	Straw Steel	9
" "	" +4	Lime hard Steel	9
" "	" +(5)	" Copper hard	10
" "	" +6	Pale Gold	5
" "	" +7	Pale	5
" "	" +8	Pale hardened	5
" "	" +9	Copper	10
" "	" +10	Copper hard	5
" "	" +11	Yellow Composition	10
" "	" +12	Brass White	5
" "	" +13	70% Cu + 30% Zn	6
" "	" +14	60% Cu + 40% Zn	8
" "	" +15	80% Cu + 20% Zn	5
" "	" +16	90% Cu + 10% Zn	5
" "	" +17	German Silver	9
	18	Pewter	10

Right — left

Right — left

Sulphate of Copper

	+ 19	Britannia	5
	+ 20	Zinc	5
	+ 21	white cast Iron	10
	+ 22	Grey cast iron	10
	+ 24		
	+ 25	50% Cu 50% Zn	9
	+ 26	50 parts Cu 60 parts Zn	5
	+ 27	50% Cu 50% Zn	5
	+ 28	40% Cu 60%	5
	+ 29	Lead	10
	+ 30	30% Cu + 70% Zn	15
	+ 31	20% Cu + 80% Zn	8
	+ 32		
	+ 33		
	+ 34	10% Cu 90% Zn	10
	+ 35	70% Cu 30% Iron	5
	+ 36	Babbitts metal	9
	+ 37	Tin	10
	38		
	39		

Sulphides of Copper

Sulphur Copper

40	80% Zn 20% Cadmium	5
41	70% Zn 30% "	5
42	60% Zn 40% "	10
43	50% Zn 50% "	10
44	40% Zn 60% "	10
45	30% Zn 70% "	10
46	20% Zn 80% "	10
47	10% Zn 90% "	14
48	Sulphide of Zinc	20
49		
50	10% Cu 90% Zn	15
51	80% Cu 20% Zinc	10
52	30% Cu 70% Lead	13
53	90% Cu 10% Lead	10
54	80% Cu 20% Lead	10
55	70% Cu 30% Lead	10
56	60% Cu 40% Lead	10
57	50% Cu 50% Lead	13
58	40% Cu 60% Lead	15
59	66⅔% Cu 33⅓% Lead	10

Sulphides of Copper

			Page 13 Copper
"	"	60	Ball metal 10% Zn	10
		61	Sulphide of iron	13
"		62	60% Cu + 40% Sn	15
"		63	50% Cu + 50% Sn	15
		64		
"	"	65	40% Cu + 60% Sn	15
"		66	30% Cu + 70% Sn	14
"		67	20% Cu + 80% Sn	15
"	"	68	70% Cu + 30% Sn	12
"		69	80% Cu + 20% Sn	15
"	"	70	70% Cu + 30% Sn	13
"		71	90% Cu + 10% Sn	14
"	"	72	20% Cu + 80% Fe	15
"	"	73	20% Cu + 80% Fe	15
"	"	74	60% Cu + 40% Fe	10
"	"	75	50% Cu + 50% Fe	10
"	"	76	30% Cu + 70% Fe	10
"	"	77	20% Cu + 80% Fe	15
"	"	78	10% Cu + 90% Fe	15
		79	90% Zn + 10% Sn	14

Sulphides of Copper

		Rupees	Days
80		80% Zn + 20% Sb	15
81		70% Zn + 30% Sb	15
82		60% Zn + 40% Sb	15
83		50% Zn + 50% Sb	17
84		40% Zn + 60% Sb	18
85		30% Zn + 70% Sb	20
86		10% Zn + 90% Sb	20
87		20% Zn + 80% Sb	15
88		90% Pb + 10% Sb	20
89		80% Pb + 20% Sb	19
90		70% Pb + 30% Sb	15
91		60% Pb + 40% Sb	17
92		50% Pb + 50% Sb	15
93	Copper Rhodonite		10
94	Rhodonite 7% Cu 22 Sn		15
95	Muntz Metal 5 Cu 43½ Zn + 3½ Pb		10
	Muntz Metal 5 Cu 40% Zn, 4.5 Pb		17
96	10% Pb + 90% Sb		16
97	20% Pb + 80% Sb		15
98	30% Pb + 70% Sb		19

Sulphide of Copper

		Right	Left
"	99 40% Pt + 60 Pt.		15
"	100 Rose Metal 40 Pt		
	60 Sn. 100 Pt		20
"	101 Lead Phosphide		15
"	102 Tin Phosphide		15
"	103 Iron Phosphide		15
"	104 Copper + Tin Sulphides		3
"	105 Nickel sulphide		15
	106 90% Pt + 10% Cd		15
	107 30% Pt + 70%		15
	108 70% Pt + 30% Cd		12
	109 60% Pt . 40% Cd		20
	110 50% Pt . 50% Cd		30
	111 40% Pt 60% Cd		20
	112 50% Pt 50 Cd		15
	113 Phosphide		35

Sulphide of Copper

Antimony Sulphide Right left 45

$Sn\,S$ } Equal parts
Cu_2S } 20 grm

It acts very strong. It would to about 40° to the left & then backwards & forwards, would not stay in one place.

$Sn\,S$ 30 grm
Cu_2S 10 grm

It gave a deflection of about 10° to the left but would not stay there, acting in a sort of aperiodic way.

$Sn\,S$ 10 gm
$Cu_2\,S$ 30 gm

Deflection of about 10 to the left

$Ni\,S$ 30 gm
Sb_2S 10 gm

Deflection of about 1° to the left

$Sn\,S$ 20 gm
S_2 20 gm

Above no deflection

$Sn\,S$ 10 gm
Bi_2S_3 20 gm

About 5° to the left

$Sn\,S$ 30 gms

Bi_2S_3 15 gms

A deflection of about 5° to the right

$Ni\,S$ 20 gms

Bi_2S_3 40 gms

Gr give an deflection

$Ni\,S$ 10 gms

Bi_2S_3 30 gms

Gr gave a deflection of about 5° to the right

20 grm Bb
20 grm Cu + S.
20 Bb

It gave me a deflection of about 15° to the right of O.

---

80 grm Bb
25 S
50 Cu

It gave a deflection of about 17° to the right

Ferric Oxide Metallic Copper + Sulphur
a deflection of about 10° to the right

Lead Sulphides } equal parts
Copper Sulphides } 20° left

Lead sulphide 80 gms.
Copper sulphide 10 gms.
7° to the right

Lead Carbonate
Copper Oxide 5° to the left
Carbon bisulphide

Iron ; Copper Zinc
Cadmium Sulphur
15° to right

12 gms Sn + 12 Cu + S
5° to the left

8 gms Pt + 4 gms Sb + 2 cc S
10 to left

14 gms Bi + 20 gms Cu + S
10 mgtt

Cu_2S + In ..
Deflection 3 s to the left

---

7 Sb + b Cd + 27 Cu_2S
On a bright spark
It gave a deflection
of about 30° Rochelle
In other places it
went as far as 15 to
the right

Sulphate of Copper

Old (Gar. 45°

new ones	
1	10° Copper
2	5 "
3	8 "
4	N.G. 0°
5	0 "
6	5 "
7	5 "
8	7 "
9	9 "
10	10 "
11	5
12	5

Tellurium. October 79 (57)

Through 150 Ohms 100° th

the Cell

Bismuth Phosphide, 20° right

Zinc " N. G

Tin " "

Copper " "

Iron Arsenide "

Nickel " "

Aluminium " "

Grey cast iron fused with sanguis draco N. G

Copper sulphide fused with chlorhydric acid N. G

Zinc Arsenide N. G

Iron Phosphide "

Nickel "

Copper Phosphides + Zinc Arsenide, N.R.

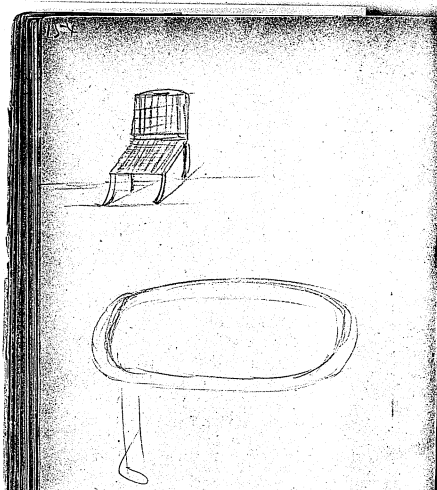
Cobaltic Oxide, 15° Left-

Double Phosphides Copper + Nickel N.R.

Sulphides of Arsenic + Zinc 15° Left-

Copper + Iron Sulphides 5° Irregular

Cu_2S + As_2S_3	70°	Left-
Cu_2S + Sb_2S_3	5°	"
" + As_2S_2	15°	very left- mutually
" + BaS	90°	left-
" + SnS	30°	"
" + H_3S_2	25°	"
" + CaS	30°	"
Cu_2S + $PbSO_4$ equal weights	20°	"
" + Antimonic oxide "	20°	"
" + P_2O_4, Cryst. "	10°	"
" + Lead arsenide "	10°	right-
" + Antimony Sulphantic "	10°	Left-
" + " Crocus "	35°	right-
" + ZnS	20°	Left-
" + Zn_3As_2 N.R.		



$Cu_2S + P_2S$ 15° night

$Cu_2S + MoS_2$ "

$Sb + K$ Alloy 15° "

$P + Mg$ " N.R.

Cobalt Arsenide "

" Phosphide 5° night

Nickel "

Copper Antimonide "

Copper Phosphide "

Copper Antimonide + Bismuth Phosphide
Nickel Phosphide + Zinc Phosphide
Antimony Arsenide + Copper Phosphide
Cobalt Arsenide
} N.R.

Lead Sulphide 2 + Nickel Phosphide 1 10° night

Phosphorus Bronze 5% Sb N.R.

Copper Phosphide + Zinc Sulphide 1/2 Copper "

Zinc Sulphide 10° "

Copper Phosphide + Boron Sulphide Carbon 5° "

Copper Phosphides & Arsenides + Tin Phosphides	"
Sulphides Arsenic & Antimony	"
Oxides from Rivières	25° Sept.
$PbS + Sb$	5° mgN.
$Cu + Zn +$	N. E.
$" + " + Cu_2S$	"
$Cu_2S + As$	30 hrs Sinky powder Good
$" + Sb$	25° Sept. Good ex-
$" + P$	" " "
" & Sulphides	15° " " "
$PbS + Sb$	10° mgN. = Metals
$Fe + PbS$	N. E.
$Cu + Sb + As$	" "
Arsenides & Sulphides	100 " Steam = 30°

Covered bars of Carbon (C) with copper film, deposited by electrolysis, then exposed to fumes of sulphur, — caused the copper film into sulphide; by this means obtained bars of carbon coated with films of copper sulphide

No Good

Performed a combination by casting a bar of lead and then encasing it with the double sulphide

Dep. to left — 8-1 ad-tings/16 remaining on cube weighing 4.250

64

Cast a bar of lead sulphide and then coated with metallic copper. By placing two sulphides in contact with the cube and the copper with the other pole obtained a deflection of 2.35° to right

---

Copper sulphide treated in same way with much feeble

Metallic copper encased with double sulphide —

Def. 7° to left.

Took a bar of Lead 167
Sulphide which gave
good result
Took the sulphide
broken into small pieces,
mixed with
added in a crucible,
the crust
Put the
allowed
in crucible
Low resistance
Repeated the operation
results Bump 25°
Button 40°

Mixed the coarsely powdered & sifted with sulphur, and fused in graphite crucible; allowed to crystallize in button in crucible

Def 50°+55°

Cast two bars of [illegible] melted the sulphid with 1/5 of its sulphur

Broke [illegible] def. [illegible]

Two bars lead sulphid
Same as preceding (1/5 sulphur)
Def. 150 [illegible]

Broke these bars into small pieces, and mixed equal weights of the two sulphids

with sulphur and put
in graphite crucible & then
cast in bars

Def. 11° left.

Giving same as last
after sulphide alone.

Broke three bars into
small pieces, and fused in
crucible without sulphur,
and cast again.

Crystalline fracture
larger and coarser

Def 20° left.

Repeated the operation

Def. 85° left

The bars very homogeneous, fracture fine grained.

The button that remained in the crucible was of a coarse crystalline fracture and gave a deflection of but a few degrees, 25°-30°

Repeated the operation

Def. 70° at first, going up to 85° to right

Fracture crystalline

Refused the bars once more and cast.

Def. 85° to 95° to right

Bars very homogeneous fracture

of Falls-granular, most [illegible]
so fine grained as to appear
glassy. Cast this bar
[illegible] & c. cannot harden [illegible]
he[illegible]

Re-fused once more and
cast.

Def. 45° & 65° Bright

Bars homogeneous, [illegible] fine
fine grained - Cast [illegible]

Re-fused once more and
cast.

Def. 75° Bright

Fracture crystalla-granular

Broke these bars into small pieces and fused with ~~pieces~~ pieces of Iridium in Stafford crucible then cast into bars

Def. 15° to Left

Fracture even, fine grained.

Alloyed as first & cast bars in crucible. Fracture uneven, crystalline.

Def. same as bars

Broke the bars into small pieces and fused with more Iridium.

Def. 10° to left

Fracture uneven, crystalline - granular

Refused the bars with more sulphur, and recast.

Def 7° to Left.

Bars very homogeneous, fracture conchoidal, fine grained: breaks along the longer axis of the bar in long splints

Re-fused the bars with more sulphur, and recast.

Def. one bar 6°, the other 10° to Left.

Fracture coarse crystalline.

Remelted the bars without sulphur, & cast.

Def. 15° to Left.

Fracture uneven, crystalline.

Re-rolled the bars without subsequent annealing.

Def. 35° & 60° bright

Fracture uneven, crystalline; one end of both bars fine grained - the rest of the bars were not homogeneous throughout.

Re-rolled again

Def. 30° & 35° bright

Fracture crystalline

Re-rolled again.

Def. 25° to 30°

Less internal resistance and the fibres of metallic copper on end of bars.

Fracture uneven, radio-crystalline

Lines Longer axis & bar somewhat

Cause of radiation of crystals

182

183

Re-melted again.

Def. 20° & right

Low internal resistance (fine & glassy)

Fracture uneven, radio-crystalline

Re-melted again at lower heat

Def. 12° & 16° to right

Fracture imp. crystalline, velvety lustre

Remelted again.

Def. 3° ~~to left~~ full

Bars very brittle, cracked & broken

Taken out of mould; fracture uneven, crystalline, lustre velvety, iridescent

---

Re-melted again
Def. 15° to right
Fracture uneven, crystalline, basic vitreous.

Re-melted again
15° to right

Re-melted again
Def. 20° to left
Fracture uneven, crystalline, basic vitreous, indiscernible

Re-melted again.
Def. 20° to left
same as preceding
Limit

186

Fused together equal weights of Cu_2S & Pb_2S in graphite crucible. Two cast bars.

Def. 15° to left

Fracture uneven, coarse crystalline

Remelted the bars and recast.

Def. 10° to right

Fracture uneven, coarse crystalline

Remelted again.

Def. 10° to right

Fracture uneven, coarse crystalline

Remelted this time with sulphur. Def. 3° to left.

Fracture fine grained.

Cast at low heat.

Intermediate result

Remelled again - without [illegible]
suppuration.
D/c 10° + light -
Fracture even, firmly [illegible]

Remelled again.
D/c 15° + light -

Lead Sulphide.

Gives deflection to right /
with excess of sulphur gives
deflection to left.

If determinate observation
lead sulphide in its
products seems to be the
determinant on the amount of
sulphur in certain
containing a
it gives new deflection, it
internal resistance is
and thus quantity X certain
a less quantity than X
deflection to the
internal resistance
containing a greater quantity

[illegible] x w[illegible] to a certain point
it adheres to the right and
[illegible] resistance is
low; passing up and that
point the adhesion is to the
left, and the amount of adhesion
& resistance seem to be in-
versely as the amount
of [illegible] contained in the bar
the greater the excess of sulphur
the less adhesion and the
lower resistance, and conversely

16 oz. $CaCl_2$
15.28 oz. Na_2CO_3

44.45 oz. $CaCO_3$
16.86 oz. $NaCl$

16 oz. $CaCl_2$ + 15.28 oz. Na_2CO_3 =
14.45 oz. $CaCO_3$ + 16.86 oz. $NaCl$ + .71 oz.

111 : 106 :: 16 : X

111) 160 (14.45
111
490
440
50

106 : 117 :: 15.28 : X

106) 1787.72 (16.86
106
727
636
917
848
692
636
56

14.45
16.86
31.31

1 lb. Carb Soda + 10 H_2O
1 lb. Chloride Lime + 10 H_2O

$CaCl_2 + Na_2Cl_2 = CaCO_3 + 2NaCl$

Ca Cl Na Cl
40 35.5 23 35.5
$CaCl_2$ = 111 Na_2Cl_2 = 106
40, 71 46, 71

111 $CaCl_2$ + 106 Na_2 [illegible] =
100 $CaCO_3$ + 117 NaCl

111 : 106 :: 16 : X

111) 1696 (15.28
111
585
555
300
222
780
666
114

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Lead sulphide as formed (Page 205)

(1) Melted 70 grams of the sulphide as formed in the ordinary way (page 4) heating metallic lead in contact with excess of sulphide in crucible. Powdered antimony and sulphur added and cast.

(2) 70 grams of this sulphide together with 10 grams of sulphur, both finely powdered and mixed.

(3) 70 grams sulphide with 20 grams sulphur; both in finely divided state and mixed.

(4) Same as preceding, except greater amount sulphur 35 grams

(5) 70 grams sulphide with 17.5 grams free sulphur; after fusion, 10 grams more sulphur added, and when in the liquid state was cast.

(6) Same as preceding; except 12.5 grams free sulphur were added after fusion instead of 10.

(7) 70 grams lead in together with 10 grams sulphur were mixed from a red hot crucible and fused. Then 10 grams more free sulphur were added, and before all the free sulphur was driven off the whole was poured into a mould.

(8) Same as preceding, except 20 grams free sulphur were added after fusion.

(7) 70 grams sulphide was mixed with 10 grams sulphur and fused in graphite crucible a piece of roll sulphur was fused in crucible with the sulphide was in a state of fusion, and before removing the free sulphur had oxidized the whole was poured into mould.

(8) Same as preceding except 20 grams sulphur were used instead of 10.

(9) Prepared the sulphide by heating metallic lead in contact with sulphur. This was then broken up and mixed with more sulphur and heated until the excess of sulphur was all driven off (dull red heat); part of this was then mixed with a small amount of sulphur and fused; the whole well digested. It was cast.

(10) Same as preceding except, after the liquefaction had taken place it was kept in the fire for 30 minutes. It was then cast.

(11) Same as preceding, the mass becoming of a bright color in the fire for 30, it was kept in for 60 minutes.

(12) Same as 10, except after liquefaction a small piece of sulphur was introduced, and before the excess of sulphur was driven off it was cast.

(13) A small quantity of free sulphur in bottom of mould otherwise same as preceding

(14) Same as (12) —

Filled graphite crucible with the lime and imbedded bar of sulphide in it, fired and exposed to red heat for an hour

20

1 Daniell cell through 620 ohms = 115°

Different ... of lead sulphide gave the following results through 315 ohms

17°, 23', 16°, 25°

115° ÷ 17° = 6.8 × 2 = 13.6
115° ÷ 23° = 5 × 2 = 10
115° ÷ 16° = 7.2 × 2 = 9.2
... 25° = 4.6 × 2 = ...

Double sulphide lead ...

15° ... ÷ 15° = 7.8 × 2 = 15.6

1 Daniell cell. Through 620 ohms = 275°

Lead Sulphide

No. 1 Through 3,167 ohms = 15°

No. 2 ... = 34°, K = ... Works ... ohms

No. 3 ... = 21° ... .24 ...

No. 5 Through ... = ... R 1.2 ohms

... 65° R 2.3 ohms

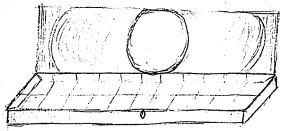
... Works ... ohms

No. ... Through ... ohms

No. ... = ...

K = ... ohms

I Daniels Thousand 2[illegible]
= 282°
(9). Through 3100 Chains = 30°
(10) " " " = 10°
[illegible]
Tellwoods Through 500 Chains
= 140°
(12) Through 300 Chains = ~~[illegible]~~ 48°
(13) " " " = 26°
(14) " " " = 37°



This is meant for a box

This is a box of some kind

This is some kind of a box

A box of some kind this is

272

273

HNO_3 $\frac{1}{2} = 8$

HCl $\frac{1}{3} = \frac{6}{14} = 4$ lbs.

$3\frac{1}{2}$

~~Heck's Thermopile~~

~~Jacket assembly~~ Heck

Heck's Thermopile

E.M.F. about ½ Daniel's

Flame (white cone)

impinging on all the ends

of elements

R. 1.2 Ohms

~~15 elements~~

20 - 5 = 15 elements

Edison's Thermopile

E.M.F. ¼ Daniel's

R. 3 Ohms 11 elements

12

Daniels 600 Ohms 143-0

21

~~Hick's Thermopile~~

~~I found a couple [illegible]~~

Hanck's Thermopile

E.M.F. 7 about 1/2 Daniels

Flame (point-cone) impinging on all the ends of elements

R. 1.2 Ohms

~~15 elements~~

20 - 5 = 15 elements

Edison's Thermopile

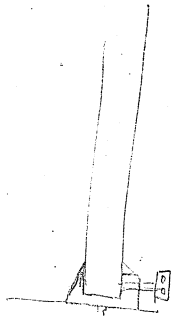
E.M.F. 1/4 Daniels

R. 3 Ohms 4 elements

Daniels Bell Battery 37

6 2 D Ohms 1.3-0

so that the bars are
more homogeneous in their
cast — as that is do
not contain any globules
of metallic lead as in
the first lot —



Steam Experiments
with the double Sulphide of
Lead & Copper

The first lot of beans germinated some time after some deflection of 15° to 25° to right

The last lot cast gives but 5° to left

The double sulphide was prepared alike in both cases with this exception that in the last lot sulphur was added to the mixture of pulverized sulphides before fusing in crucible

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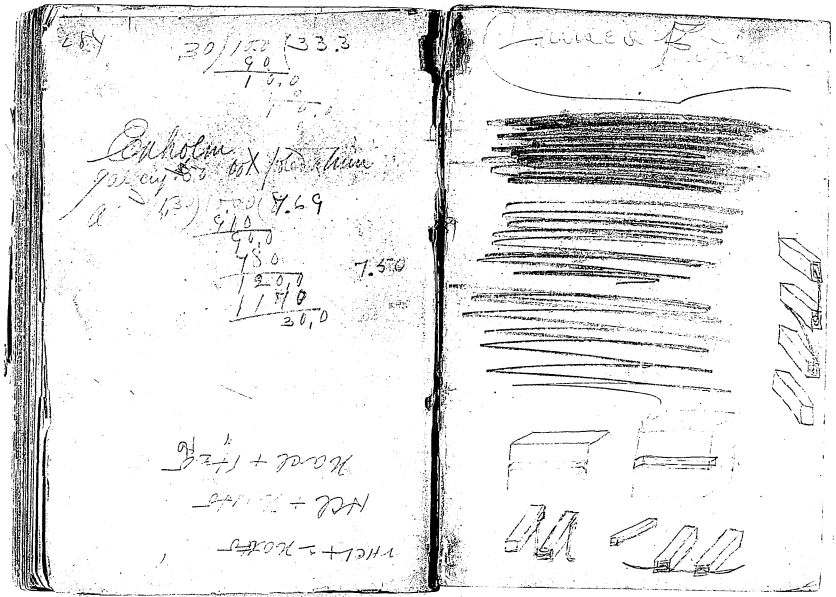

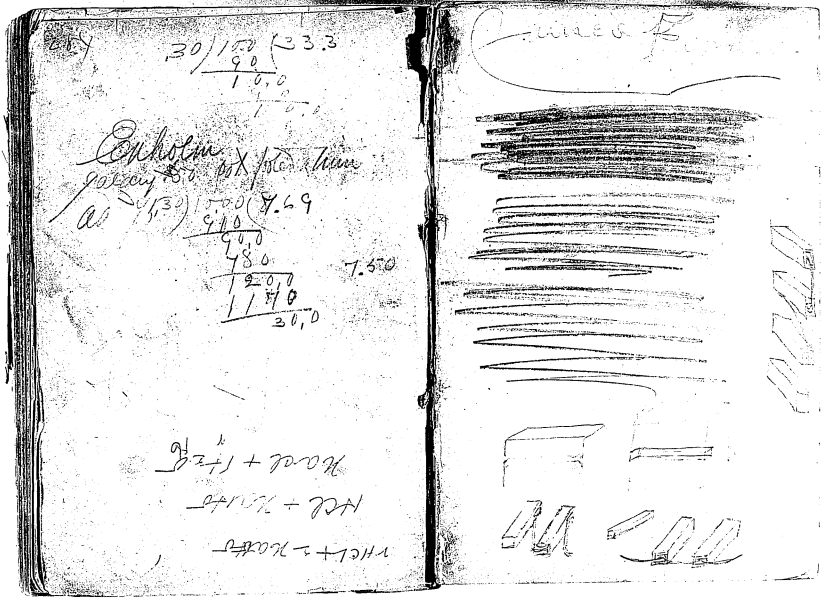

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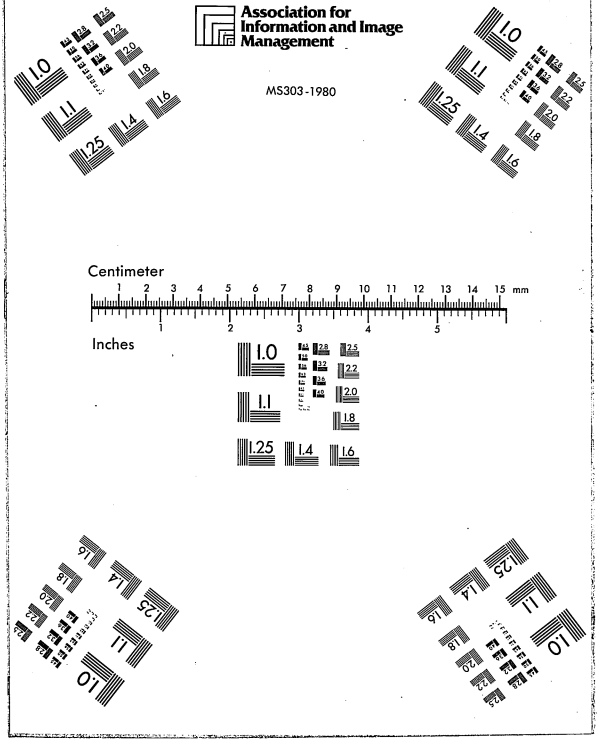
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